DEPARTMENT OF COMMERCE
BUREAU OF FISHERIES
HENRY O'MALLEY, Commissioner

PROPAGATION AND DISTRIBUTION OF FOOD FISHES

FISCAL YEAR 1923

By GLEN C. LEACH
Assistant in Charge, Division of Fish Culture

APPENDIX XIII TO THE REPORT OF THE U. S. COMMISSIONER OF FISHERIES FOR 1923

Bureau of Fisheries Document No. 964

PRICE, 15 CENTS

Sold only by the Superintendent of Documents, Government Printing Office
Washington, D. C.

WASHINGTON
GOVERNMENT PRINTING OFFICE
1924

PROPAGATION AND DISTRIBUTION OF FOOD FISHES, FISCAL YEAR 1923.[1]

By GLEN C. LEACH, *Assistant in Charge, Division of Fish Culture.*

CONTENTS.

INTRODUCTION. Page.

Fishes of interior waters ... 3
Commercial fish culture ... 4
Cooperation with States, other Federal agencies, and foreign governments ... 5
Sentiment in favor of fish protection ... 7

PART I.—FISH PRODUCTION: PROPAGATION AND RESCUE WORK.

Tabular summaries of operations ... 8
Species of fishes handled ... 8
Output ... 9
Egg collections ... 10
Fish-rescue work ... 11
Stations and substations and output of each ... 13
Egg-collecting or auxiliary stations ... 18
Fish food used at hatcheries ... 20
Hatchery fish-cultural notes ... 21
Method of preparing food for young salmon ... 21
Test of copper sulphate for eradication of fungus ... 22
Parasitic affection in whitefish jars ... 22
Hatching eggs in gravel ... 23
Commercial fishes ... 23
Pacific salmons ... 23
Afognak (Alaska) station ... 24
Yes Bay (Alaska) station ... 25
Baker Lake (Wash.) station and substations ... 26
Baker Lake (Wash.) station ... 26
Birdsview (Wash.) substation ... 27
Brinnon (Wash.) substation ... 28
Duckabush (Wash.) substation ... 28
Quilcene (Wash.) substation ... 29
Sultan (Wash.) substation ... 29
Quinault (Wash.) station ... 29
Clackamas (Oreg.) station and substations ... 33
Clackamas (Oreg.) station ... 34
Upper Clackamas (Oreg.) substation ... 34
Little White Salmon (Wash.) substation ... 34
Big White Salmon (Wash.) substation ... 35
Rogue River (Oreg.) substation ... 35
Applegate Creek (Oreg.) substation ... 36
Sandy River (Oreg.) substation ... 36
Washougal River (Wash.) substation ... 36
Salmon (Idaho) substation ... 37

[1] Appendix XIII to the Report of the U. S. Commissioner of Fisheries for 1923. B. F. Doc. No. 964.

Commercial fishes—Continued. Page.
Pacific salmons—Continued.
Baird (Calif.) station and substations 37
Baird (Calif.) station 38
Battle Creek (Calif.) substation 39
Mill Creek (Calif.) substation 39
Great Lakes fishes 39
Duluth (Minn.) station 40
Northville (Mich.) station and substations 41
Northville (Mich.) station 41
Charlevoix (Mich.) substation 41
Alpena (Mich.) substation 42
Put in Bay (Ohio) station 43
Cape Vincent (N. Y.) station 45
Bryans Point (Md.) substation 46
Buffalofish 47
Atchafalaya (La.) substation 47
Marine fishes 47
Boothbay Harbor (Me.) station 48
Gloucester (Mass.) station 49
Woods Hole (Mass.) station 51
Anadromous fishes of the Atlantic coast 53
Shad 53
Bryans Point (Md.) substation 53
Shad and river herrings 53
Edenton (N. C.) station 53
Striped bass 54
Weldon (N. C.) substation 54
Atlantic salmon 55
Craig Brook (Me.) station 55
Rescue of stranded food fishes 55
Mussel infection in conjunction with the rescue of landlocked fishes 57
Fishes of minor interior waters 57
Rocky Mountain trout stations 58
Bozeman (Mont.) station and substations 58
Bozeman (Mont.) station 58
Meadow Creek (Mont.) substation 59
Glacier National Park (Mont.) substation 60
Leadville (Colo.) station 60
Yellowstone National Park (Wyo.) substation 61
Saratoga (Wyo.) station and substation 62
Spearfish (S. Dak.) station 63
Springville (Utah) station 64
New England trout and salmon stations 66
Berkshire (Mass.) station 66
Craig Brook (Me.) station and substations 68
Green Lake (Me.) substation 68
Grand Lake Stream (Me.) substation 69
St. Johnsbury (Vt.) station and substations 70
St. Johnsbury (Vt.) station 70
Holden (Vt.) substation 70
York Pond (N. H.) substation 71
Nashua (N. H.) station 72
Combination trout and pond stations 73
Erwin (Tenn.) station 73
Manchester (Iowa) station 74
Neosho (Mo.) station and substations 75
Roaring River (Mo.) substation 77
Bourbon (Mo.) substation 77
Greer Springs (Mo.) substation 78
Langdon (Kans.) substation 78
White Sulphur Springs (W. Va.) station 79
Wytheville (Va.) station 80

Fishes of minor interior waters—Continued. Page.
Pond fish-cultural stations 82
Cold Springs (Ga.) station and substations 82
Harris Ponds (Ga.) substation 84
Edenton (N. C.) station 84
Louisville (Ky.) station and substation 84
Cairo (Ill.) substation 85
Mammoth Spring (Ark.) station 85
Orangeburg (S. C.) station 87
San Marcos (Tex.) station 88
Tupelo (Miss.) station and substation 89
Friars Point (Miss.) substation 90
Central station and aquarium, Washington, D. C 90

PART 2.—DISTRIBUTION OF FISH AND FISH EGGS.

Brief review of the work 91
Summaries of distribution 92
Distribution to all applicants 92
Assignments of fish and fish eggs to State and Territorial fish commissions 95
Methods of distribution 96
Distribution of fishes of interior waters 97
Car No. 3 97
Car No. 4 98
Car No. 7 99
Car No. 8 100
Car No. 9 101
New equipment for use in shipping live fish 101
Electric air compressor 101
"Question mark" aerator 103
Jet aerator 103
Aquarium cleaner 104
Cost of distribution 104

INTRODUCTION.

During the fiscal year ended June 30, 1923, the bureau's fish-cultural activities were confined necessarily to certain well-established fields, it being impossible to extend the work into new territory because funds were not available for the purpose. Unless increased appropriations are allowed for the propagation and distribution of food fishes, the work of the division can hardly be enlarged beyond its present limits, and prospects at this time point to a gradually declining output. Up to the present time the pre-war record of the bureau has been more than maintained without any increase in the funds applied to the work. However, this high standard of efficiency can not be continued indefinitely in the face of an increase in the cost of all materials and labor entering into the work, the prices of practically everything used in connection therewith being approximately 67 per cent higher than in 1917.

FISHES OF INTERIOR WATERS.

The demand for fish for stocking interior waters of the country increases at the rate of about 10 per cent a year. The value of these interior fisheries can hardly be overestimated. They add millions of pounds annually to the Nation's food supply, and in many locali-

ties constitute the only source of fresh fish supply available. They make possible the extension of the fisheries and the establishment of fishing in many formerly unproductive waters. They afford a splendid means of recreation to millions of people, bringing them into contact with the great outdoors.

The increasing use of the automobile and the fact that almost every automobile tourist is a fisherman have had an almost disastrous effect on many waters, however. With their existing facilities the States have not been able to cope with the situation, but in anticipation of future conditions many of them have made preparations for a great increase in their operations. In this respect the State of North Carolina probably leads. The opening up of its wonderful mountain regions through the construction of good roads is sure to result in an influx of tourists and the consequent depletion of many of its waters unless fish-cultural work is prosecuted on an extensive and systematic basis. In recognition of this outlook the State now has plans in contemplation for the establishment of a system of hatcheries and the enactment and enforcement of adequate fishery laws.

The bureau has taken the lead in fish-cultural work, and the activities of the various States along this line have, for the most part, been patterned after its work. In many instances the States have succeeded with their plans by employing the bureau's skilled and experienced men at higher salaries than the bureau has been able to pay. In view of this situation it is felt that the bureau is little more than a training school for fish-culturists, and that in turning the services of such men over to the States it is doing a public work of great value. It is fully recognized that the fish-cultural experience of the bureau is for the public benefit, and the results of this experience are constantly being disseminated through the issuance of reports and bulletins and also in letters on special subjects.

COMMERCIAL FISH CULTURE.

While the cultivation of fish for stocking interior waters is an important phase of the bureau's activities, its work in the propagation and distribution of the so-called commercial fishes has a much greater significance so far as its economic value to the country is concerned. This work has probably attained its highest efficiency on the Pacific coast, and especially in Alaska, where the salmons constitute one of the most important natural resources. Had it not been for the combined efforts of the bureau and the States to conserve this valuable asset, it is probable that its value would by this time have declined to a point where it would neither have interested the white man as an investment nor served as a means of sustenance to the Indian.

In many instances the spawning beds of the salmon have been ruined by logging operations, while in other cases the ascent of the salmon to suitable spawning grounds has been cut off by the erection of insurmountable power dams. The salmon congregate at the entrance of certain coastal streams at a particular season of the year,

and if they find ascent to their natural spawning grounds in the headwaters cut off by a barrier, the parent fish die, their eggs are wasted, and the supply of salmon is reduced to that extent.

It is part of the work of the bureau's hatcheries to seine these fish from below the barriers and to remove their eggs and incubate them. The vitality and fertility of the salmon egg is wonderful. If carefully handled and cared for, approximately 95 per cent of them will hatch. The young fish resulting from the eggs are held in ponds and troughs in such numbers as is practicable and are fed artificially until they have attained a length of 2 or 3 inches, when they are liberated. Shortly after liberation they descend to the sea and, with the exception of one species, which returns in two years, they remain in salt water for four or five years. At the expiration of that time they seek the headwaters of various coastal streams, where they reproduce and then die, completing the life cycle. It can readily be seen that hatchery work of this character is of the greatest importance if this valuable and extensive industry is to be maintained.

A somewhat different problem is presented by the fishes of the Great Lakes and Atlantic coast. Eggs from these valuable commercial species are taken only from fish caught for the market by men employed to go out with the fishing boats and salvage the eggs as the fish are removed from the nets. Were it not for this work, some three or four billion eggs would be wasted annually, being sent to market with the fish and discarded in the process of cleaning. This also applies to the shad, herring, and yellow perch.

In addition to the work of salvaging eggs for propagation in the hatcheries, experienced spawn takers are detailed to accompany the offshore fishing fleet operating from Gloucester, Mass., going out on the boats for trips of a week or two weeks' duration. As the eggs from such fish as the cod, pollock, and haddock can not be held until the return of the vessel, they are carefully removed from the fish, fertilized, and planted on the spawning grounds. As in the case of the other species, these eggs would be a total loss were it not for the bureau's intervention. Being exposed to the attacks of natural enemies, the percentage of eggs hatched of those thus treated must be far smaller than that attained in the hatcheries, but as they can not be handled in hatcheries, because of the inaccessibility of the latter, it is believed even the smaller percentage hatched fully justifies the time and money expended in the work of fertilizing and returning them to the spawning grounds.

COOPERATION WITH STATES, OTHER FEDERAL AGENCIES, AND FOREIGN GOVERNMENTS.

The division of fish culture has pursued its usual policy of working in conjunction with the States so far as possible. This cooperation consists in the interchange of fish and eggs, distribution of fish, joint production of fish, and joint operation of field stations for the collection of eggs. Sometimes State authorities are supplied with eggs of certain species and in return they fill applications for fish sub-

mitted to the bureau. In one or two instances eggs have been purchased by a State for incubation in the bureau's hatcheries, but the most important cooperation is probably in the distribution of fish, as it eliminates to a great extent what would otherwise amount to a duplication of effort in the stocking of waters. The bureau has rendered valuable assistance to the States by lending the services of its experienced men to aid in solving their fish-cultural problems and to give advice and assistance in the location and establishment of hatcheries.

Such governmental agencies as the Forest Service, Reclamation Service, and National Park Service have been of much assistance to the bureau in stocking waters with fish and protecting them. In many cases employees of these services have united in an effort to protect the fish life of streams and lakes and have assisted in the propagation of fish without incurring extra expense to the Government. Through these agencies fish are transported to remote sections of the public forests and parks and released in waters where they will be comparatively free from molestation for several years. As such waters become stocked the larger fish tend to work downstream, and in this way the stocking of larger bodies of water is effected.

The bureau's interest in the fish culture of foreign countries has not lessened with the passing years. In response to requests submitted through the State Department eggs of suitable species have been furnished in as liberal numbers as conditions would warrant, and exchanges of eggs have been made with Canada to the benefit of both countries, since it has been the means of replenishing the waters of both with desirable species of fishes not otherwise obtainable.

During the fiscal year 1923 cooperative fish-cultural operations in the waters of Lake Ontario were very satisfactory. The Canadian authorities permitted the force of the Cape Vincent (N. Y.) station to make collections of whitefish and lake-trout eggs in the Bay of Quinte, and the local fishermen were very glad to assist in the work, knowing that the resulting fry would be liberated in Canadian waters. It is the opinion of the bureau that much of the success attained in the Canadian fisheries is due to past activities of the Cape Vincent station. The fisheries of the lake had declined so that no eggs whatever were obtainable at any of the commercial fisheries, and every year the Cape Vincent hatchery was stocked by the transfer of eggs from other stations of the bureau, whitefish eggs being drawn from Lake Erie and lake-trout eggs from the Michigan fields. The bureau is convinced that the upbuilding of the Ontario fisheries has been brought about through the persistent stocking of the lake through the operations of the Cape Vincent hatchery. In recent years the Canadian authorities have generously permitted the bureau's employees to collect spawn in Dominion waters, but on the other hand the annual release of several hundred million fry from Cape Vincent station in this lake must have been a great factor in the upbuilding of the Canadian fisheries.

SENTIMENT IN FAVOR OF FISH PROTECTION.

One of the bureau's functions has been to impress upon the various States having inadequate fishery laws, or none at all, the necessity for taking steps to protect the fish life within their boundaries. It is felt that the bureau can not afford to make large plants of fish in the waters of States that have no laws providing for their protection. Such legislation should not only establish an adequate closed season so that the fish may spawn without molestation but should provide for regulations to cover a bag limit and a minimum size at which fish may be taken. It should rigidly prohibit the dumping of refuse in fish-cultural waters, as the presence of waste matter drives the fish away, destroys their feeding grounds, and makes it difficult ever to restore fishing in waters that have been contaminated.

It is gratifying to note that country clubs and other associations throughout the country are taking more interest in protection than ever before. In many instances such organizations have leased large tracts of land and have incurred considerable expense in stocking the waters located thereon. Some have gone so far as to maintain small hatcheries, while others have sought the aid of the bureau in their fish-cultural ventures, with the understanding that after reserving a sufficient supply of the fish produced for their own use the remainder will be planted in public waters.

The effect of the growing sentiment in favor of protection has been far-reaching and beneficial. Large numbers of men and women in different sections of the country are at the present time forming organizations having for their object the adoption of measures for adequately conserving natural resources, and the good results of their efforts along this line are very apparent. This sentiment in favor of the preservation of fish life is probably stronger throughout the Mississippi Valley than anywhere else. The people of that section look upon fish conservation as a matter vitally affecting their personal interests. A diminishing supply means the cutting off of their only means of obtaining fresh fish for food, and they are very urgent in their demand that the fishes stranded in landlocked pools and lakes in the flooded regions of the Mississippi River be transferred to living waters. Before this river became obstructed by power dams it constituted a natural fish hatchery for the great Middle West, but, as these dams are recognized as a national necessity, their greater value than the fish life is not questioned. The construction of the dams has resulted in cutting off the ascent of the fish to headwaters and it is thought to be no more than just that fishes stranded in the overflowed sections should be rescued and returned to the parts of the rivers thus cut off.

The sentiment in favor of this salvage of fishes from the overflowed lands has become so great that the resources not only of the bureau but of the States of Minnesota, Iowa, Wisconsin, and Illinois, as well, have been severely taxed in an effort to increase the scope of operations. It is estimated that during the fiscal year 1923 approximately one million pounds of fish were thus saved from destruction.

Part 1.—FISH PRODUCTION: PROPAGATION AND RESCUE WORK.

TABULAR SUMMARIES OF OPERATIONS.

SPECIES OF FISHES HANDLED.

The work as conducted during the fiscal year ended June 30, 1923, involved 58 species of fish, as indicated in the accompanying list, each species listed being the subject of either artificial propagation or rescue work. The majority of the fishes rescued from the overflowed regions of the Mississippi River are not distributed but are returned to the river. These include some species of the catfishes, sunfishes, suckers, carp, and pike. Very few of the commercial species are supplied on application.

LIST OF SPECIES HANDLED.

THE CATFISHES (SILURIDÆ):
- Blue catfish (*Ictalurus furcatus*).
- Channel catfish (*Ictalurus punctatus*).
- Horned pout, bullhead (*Ameiurus nebulosus*).
- Mississippi catfish (*Ameiurus lacustris*).
- Yellow catfish (*Ameiurus natalis*).
- Black bullhead (*Ameiurus melas*).
- Mud catfish (*Leptops olivaris*).

THE SUCKERS (CATOSTOMIDÆ):
- Mongrel buffalofish (*Ictiobus urus*).
- Common buffalofish (*Ictiobus cyprinella*).
- Smallmouth buffalofish (*Ictiobus bubalus*).

THE CARPS (CYPRINIDÆ):
- Asiatic carp (*Cyprinus carpio*).

THE SHADS AND HERRINGS (CLUPEIDÆ):
- Shad (*Alosa sapidissima*).
- Glut herring (*Pomolobus æstivalis*).
- Skipjack (*Pomolobus chrysochloris*).

THE SALMONS, TROUTS, WHITEFISHES, ETC. (SALMONIDÆ):
- Common whitefishes (*Coregonus albus* and *C. clupeaformis*).
- Pilot fish (*Coregonus quadrilateralis*).
- Cisco (chiefly *Leucichthys artedi*).
- Chinook salmon, king salmon, quinnat salmon (*Oncorhynchus tschawytscha*).
- Chum salmon, dog salmon (*Oncorhynchus keta*).
- Humpback salmon, pink salmon (*Oncorhynchus gorbuscha*).
- Silver salmon, coho salmon (*Oncorhynchus kisutch*).
- Sockeye salmon, blueback salmon, redfish (*Oncorhynchus nerka*).
- Steelhead salmon (*Salmo gairdneri*).
- Atlantic salmon (*Salmo salar*).
- Landlocked salmon (*Salmo sebago*).
- Rainbow trout (*Salmo shasta*).
- Black-spotted trout, redthroat trout (*Salmo lewisi*).
- Loch Leven trout (*Salmo levenensis*).
- Lake trout, Mackinaw trout (*Cristovomer namaycush*).
- Brook trout (*Salvelinus fontinalis*).

THE SMELTS (OSMERIDÆ):
- Smelt (*Osmerus mordax*).
- Wilton smelt (*Osmerus mordax spectrum*).

THE PIKES (LUCIDÆ):
- Little pickerel (*Lucius vermiculatus*).
- Common pickerel (*Lucius lucius*).

THE MACKERELS (SCOMBRIDÆ):
- Mackerel (*Scomber scombrus*).

THE SUNFISHES, BLACK BASSES, AND CRAPPIES (CENTRARCHIDÆ):
Crappies (*Pomoxis annularis* and *P. sparoides*).
Largemouth black bass (*Micropterus salmoides*).
Smallmouth black bass (*Micropterus dolomieu*).
Rock bass (*Ambloplites rupestris*).
Warmouth bass, goggle-eye (*Chænobryttus gulosus*).
Green sunfish (*Apomotis cyanellus*).
Red-breasted bream (*Lepomis auritus*).
Bluegill sunfish (*Lepomis pallidus*).
Long-eared sunfish (*Lepomis megalotis*).
Common sunfish (*Eupomotis gibbosus*).
THE PERCHES (PERCIDÆ):
Pike perch (*Stizostedion vitreum*).
Sauger (*Stizostedion canadense*).
Yellow perch (*Perca flavescens*).
THE SEA BASSES (SERRANIDÆ):
White bass (*Roccus chrysops*).
White perch (*Morone americana*).
Sea bass (*Centropristes striatus*).
THE PORGIES (SPARIDÆ):
Scup, scuppaug (*Stenotomus chrysops*).
THE DRUMS (SCIÆNIDÆ):
Fresh-water drum, lake sheepshead (*Aplodinotus grunniens*).
THE CODS (GADIDÆ):
Cod (*Gadus callarias*).
Haddock (*Melanogrammus æglefinus*).
Pollock (*Pollachius virens*).
THE FLOUNDERS (PLEURONECTIDÆ):
Winter flounder, American flatfish (*Pseudopleuronectes americanus*).

OUTPUT.

The combined work of the fish-cultural stations and the rescue crews during the year resulted in a gross output of 4,315,857,725 eggs, fry, and fingerling fish for distribution. Losses in transportation amounted to 998,696, leaving a net total of 4,314,859,029 fish and eggs actually distributed.

Summary, by species, of net output of fish and fish eggs, fiscal year 1923.

Species.	Eggs.	Fry.	Fingerlings.	Total.
Catfish			37,092,979	37,092,979
Buffalofish	163,169,500	5,925,000	9,429,838	178,524,338
Carp	29,000,000	115,000,000	14,226,110	158,226,110
Shad		16,971,000		16,971,000
Glut herring		150,000,000		150,000,000
Whitefish	148,041,000	208,675,000	3,000	356,719,000
Cisco	10,000,000	39,000,000		49,000,000
Chinook salmon	4,205,000	720,000	28,965,045	33,890,045
Chum salmon		8,274,830	14,997,900	23,272,730
Humpback salmon		396,950	1,915,435	2,312,385
Silver salmon	100,000	8,371,025	5,910,630	14,381,655
Sockeye salmon	10,678,400	31,582,000	50,949,400	93,209,800
Steelhead salmon	1,744,000	275,000	5,339,005	7,358,005
Atlantic salmon		451,000	40,038	491,038
Landlocked salmon	76,872	727,670	92,800	897,342
Rainbow trout	2,689,960	754,000	3,408,159	6,852,119
Black-spotted trout	10,127,100	2,160,100	1,492,700	13,779,900
Loch Leven trout			43,800	43,800
Lake trout	7,253,300	34,748,415	232,080	42,233,795
Brook trout	725,300	2,841,400	8,477,250	12,043,950
Smelt	16,280,000	28,000,000		44,280,000
Pike and pickerel			905,395	905,395
Crappie			35,602,522	35,602,522
Largemouth black bass		806,500	1,342,349	2,148,849
Smallmouth black bass		449,400	79,007	528,407
Rock bass			64,035	64,035

Summary, by species, of net output of fish and fish eggs, fiscal year 1923—Con.

Species.	Eggs.	Fry.	Fingerlings.	Total.
Warmouth bass			8,350	8,350
Sunfish			26,854,257	26,854,257
Pike perch	37,275,000	63,365,000		100,640,000
Yellow perch	3,680,000	136,325,000	936,295	140,941,295
White perch			675	675
Striped bass		16,341,000		16,341,000
White bass			40,085	40,085
Fresh-water drum			49,026	49,026
Cod	650,980,000	376,813,000		1,027,793,000
Haddock	104,400,000	2,960,000		107,360,000
Pollock	33,960,000	276,098,000		310,058,000
Flounder	229,345,000	1,058,781,000		1,288,126,000
Miscellaneous fishes			15,818,142	15,818,142
Total	1,463,730,432	2,586,812,290	264,316,307	4,314,859,029

EGG COLLECTIONS.

The bureau's principal source of egg supply is the commercial fisheries, where vast numbers of eggs of valuable fishes would annually be wasted were it not for the bureau's work. In most instances they are transported to the hatcheries for incubation; but in the case of the offshore fisheries on the New England coast the spawn takers sent out to salvage the eggs fertilize and plant them on the spawning grounds, as it is impracticable to hold the spawn until the vessels return to port. In some cases eggs are taken from fish caught in nets and traps and are artificially impregnated and incubated in the hatchery, this being done to insure a higher degree of fertility than would be possible under natural conditions of spawning.

A decrease of approximately 991,000,000 is shown in the total egg collections as compared with those of the previous year. This decrease is explained partly by the prevalence of unfavorable weather during the spawning season of some of the fishes handled, and partly by lack of funds necessary to take full advantage of the opportunities for obtaining eggs in one or two instances.

Comparison of egg collections, fiscal years 1923 and 1922.

Species.	1923	1922	Species.	1923	1922
Buffalofish	179,173,600	199,906,250	Loch Leven trout	98,130	109,870
Carp	160,500,000	98,000,000	Lake trout	77,775,890	67,426,500
Shad	17,877,000	82,579,000	Brook trout	19,109,040	17,986,250
Glut herring	313,422,620	116,920,000	Smelt	42,000,000	300,000
Whitefish	537,546,000	623,100,000	Mackerel		2,022,000
Cisco	76,800,000	429,900,000	Pike perch	230,040,000	254,717,500
Pilot fish	255,000		Yellow perch	151,010,000	277,501,870
Chinook salmon	30,889,000	64,756,100	Striped bass	22,084,000	48,745,000
Chum salmon	26,513,500	22,830,000	Sea bass		32,000
Humpback salmon	1,099,200	1,722,000	Scup		3,425,000
Silver salmon	15,159,800	13,618,700	Cod	1,279,769,000	587,126,000
Sockeye salmon	97,886,000	119,214,350	Haddock	109,220,000	543,110,000
Steelhead salmon	7,946,300	7,302,800	Pollock	420,536,000	507,270,000
Atlantic salmon		572,040	Winter flounder	1,391,411,000	2,312,029,000
Landlocked salmon	852,350	445,000	Pole flounder		5,090,000
Rainbow trout	11,488,410	11,210,500			
Black-spotted trout	16,655,820	9,220,300	Total	5,437,057,660	6,428,487,830

FISH-RESCUE WORK.

The part of the bureau's work dealing with the salvaging of stranded food fishes from the overflowed lands along the Mississippi River showed a considerable decrease in results as compared with that of 1922. The following table indicates by localities and species the total numbers of fish salvaged, the numbers restored to original waters, and the numbers delivered to applicants. The summary also shows the total numbers of each species handled in all fields and returned to native waters, and the total deliveries of rescued fishes to applicants.

Number and disposition of fish rescued, fiscal year 1923.

Station and species.	Delivered to applicants.	Restored to original waters.	Total.
Homer, Minn.:			
Black bass	48,315	78,715	127,030
Buffalofish		24,593	24,593
Carp		1,008,875	1,008,875
Catfish	48,525	5,803,030	5,851,555
Crappie	47,800	10,995,470	11,043,270
Drum		18,950	18,950
Pike and pickerel		311,710	311,710
Rock bass		1,010	1,010
Sunfish	31,830	7,810,430	7,842,260
White bass		20,580	20,580
Yellow perch	11,350	518,490	529,840
Miscellaneous		534,900	534,900
Total	187,820	27,126,753	27,314,573
Bellevue, Iowa:			
Black bass	52,495	20,735	73,230
Buffalofish	150	5,590,900	5,591,050
Carp	290	7,243,830	7,244,120
Catfish	75,855	4,387,225	4,463,080
Crappie	1,449	6,651,926	6,653,375
Drum		194	194
Pike and pickerel	160	21,110	21,270
Sunfish	10,058	2,639,635	2,649,693
Warmouth bass	80		80
White bass		2,281	2,281
Yellow perch	1,950	3,930	5,880
Miscellaneous	740	7,837,392	7,838,132
Total	143,227	34,399,158	34,542,385
La Crosse, Wis.:			
Black bass	131,545	79,195	210,740
Buffalofish	480	2,799,655	2,800,135
Carp	176	4,715,154	4,715,330
Catfish	53,030	18,905,345	18,958,375
Crappie	33,135	13,488,460	13,521,595
Drum	1,185	150	1,335
Pike and pickerel		484,815	484,815
Smallmouth bass	94		94
Sunfish	21,190	11,474,150	11,495,340
White bass		7,002	7,002
Yellow perch	5,930	340,385	346,315
Miscellaneous		5,841,300	5,841,300
Total	246,765	58,135,611	58,382,376
Marquette, Iowa:			
Black bass	61,420	33,135	94,555
Buffalofish	90	473,400	473,490
Carp	75	896,600	896,675
Catfish	28,204	5,722,046	5,750,250
Crappie	347,100	3,273,500	3,620,600
Drum		16,100	16,100
Pike and pickerel		70,850	70,850
Rock bass		300	300
Sunfish	5,660	2,292,130	2,297,790
White bass		1,200	1,200
Yellow perch	5,545	44,460	50,005
Miscellaneous		369,755	369,755
Total	448,094	13,193,476	13,641,570

Number and disposition of fish rescued, fiscal year 1923—Continued.

Station and species.	Delivered to applicants.	Restored to original waters.	Total.
Rock Island, Ill:			
Black bass		5,125	5,125
Buffalofish		105,595	105,595
Carp		330,280	330,280
Catfish		784,090	784,090
Crappie		348,212	348,212
Drum		222	222
Pike and pickerel		16,690	16,690
Sunfish		691,765	691,765
White bass		777	777
Yellow perch		4,525	4,525
Miscellaneous		886,055	886,055
Total		3,173,336	3,173,336
Baton Rouge, La.:			
Buffalofish		4,750	4,750
Carp		885	885
Catfish	275	705	980
Crappie	2,572	8,028	10,600
Drum	500	4,000	4,500
Sunfish	3,700	10,000	13,700
White bass	100	325	425
Miscellaneous		188,000	188,000
Total	7,147	216,693	223,840
Simmesport, La.:			
Black bass	239		239
Buffalofish		22,550	22,550
Catfish		1,298	1,298
Carp		130	130
Crappie	500	4,225	4,725
Drum		7,725	7,725
Pike and pickerel		60	60
Sunfish	1,075	2,325	3,400
White bass		5,170	5,170
Miscellaneous		192,500	192,500
Total	1,814	235,983	237,797
Friar Point, Miss.:			
Black bass	6,520	440	6,960
Buffalofish	20	88,480	88,500
Carp		300	300
Catfish	3,525	310,760	314,285
Crappie	1,420	6,979	8,399
Rock bass	600	1,545	2,145
Sunfish	117,700	1,103,300	1,221,000
White bass		2,650	2,650
Total	129,785	1,514,454	1,644,239
Fairport, Iowa, and substations:			
Black bass		8,160	8,160
Buffalofish		96,575	96,575
Carp		29,565	29,565
Catfish	300	208,895	209,195
Crappie		78,590	78,590
Sunfish		205,630	205,630
Miscellaneous		11,200	11,200
Total	300	638,615	638,915
Summary by stations:			
Homer	187,820	27,126,753	27,314,573
Bellevue	143,227	34,399,158	34,542,385
La Crosse	246,765	58,135,611	58,382,376
Marquette	448,094	13,193,476	13,641,570
Rock Island		3,173,336	3,173,336
Baton Rouge	7,147	716,693	723,840
Simmesport	1,814	235,983	237,797
Friar Point	129,785	1,514,454	1,644,239
Fairport	300	638,615	638,915
Total	1,164,952	138,634,079	139,799,031

Number and disposition of fish rescued, fiscal year 1923—Continued.

Station and species.	Delivered to applicants.	Restored to original waters.	Total.
Summary by species:			
Black bass	300, 534	225, 505	526, 039
Buffalofish	740	9, 206, 498	9, 207, 238
Carp	541	14, 225, 619	14, 226, 160
Catfish	209, 714	36, 123, 394	36, 333, 108
Crappie	433, 976	34, 855, 390	35, 289, 366
Drum	1, 685	47, 341	49, 026
Pike and pickerel	160	905, 235	905, 395
Rock bass	600	2, 855	3, 455
Smallmouth bass	94		94
Sunfish	191, 213	26, 229, 365	26, 420, 578
Warmouth bass	80		80
White bass	100	39, 985	40, 085
Yellow perch	24, 775	911, 790	936, 565
Miscellaneous	740	15, 861, 102	15, 861, 842
Total	1, 164, 952	138, 634, 079	139, 799, 031

STATIONS AND SUBSTATIONS AND OUTPUT OF EACH.

During the fiscal year 1923 fish-cultural operations were conducted at 37 main stations and 34 substations, though at several of these work was confined principally to the rescue of stranded fishes from overflowed lands. The following table lists the main stations in alphabetical order, each of them being followed by its auxiliary substations, and includes the period of operation at each point and the number of eggs, fry, and fingerling fish distributed.

Stations and substations operated and output of each, fiscal year 1923.

[Asterisk (*) indicates that additional eggs were transferred to other stations for convenience in handling. See table, p. 17.]

Station and substation.	Species.	Eggs.	Fry.	Fingerlings, yearlings, and adults.	Total.
Afognak, Alaska	Humpback salmon			240, 000	240, 000
	Sockeye salmon	*10, 678, 400	15, 882, 000	30, 451, 000	57, 011, 400
Baird, Calif.	Chinook salmon			1, 466, 000	1, 466, 000
Battle Creek, Calif.	do			1, 587, 500	1, 587, 500
Mill Creek, Calif.	do			750, 900	750, 900
Baker Lake, Wash.	Sockeye salmon	(*)	14, 200, 000	975, 000	15, 175, 000
Birdsview, Wash.	Chinook salmon			300, 445	300, 445
	Humpback salmon	(*)		188, 645	188, 645
	Silver salmon	*100, 000	5, 977, 025	1, 227, 470	7, 304, 495
	Sockeye salmon	(*)		29, 000	29, 000
	Steelhead salmon			285, 305	285, 305
Duckabush, Wash.	Chum salmon		5, 545, 250	8, 645, 400	14, 190, 650
	Silver salmon			289, 310	289, 310
	Steelhead salmon			139, 445	139, 445
Quilcene, Wash.	Chum salmon		2, 729, 580	6, 000, 000	8, 729, 580
	Humpback salmon			1, 483, 790	1, 483, 790
	Silver salmon			752, 275	752, 275
	Steelhead salmon			545, 555	545, 555
Sultan, Wash.	Silver salmon	(*)	2, 394, 000	799, 000	3, 193, 000
	Steelhead salmon			207, 800	207, 800
Berkshire, Mass.	Brook trout			238, 500	238, 500
	Pike perch		485, 000		485, 000
	Rainbow trout			30, 900	30, 900
Boothbay Harbor, Me.	Flounder		866, 800, 000		866, 800, 000
Bozeman, Mont.	Black-spotted trout	50, 000	25, 000	825, 500	900, 500
	Brook trout		312, 500	594, 450	906, 950
	Rainbow trout	*25, 000		131, 100	156, 100
Glacier Park, Mont.	Black-spotted trout	1, 389, 700			1, 389, 700
	Rainbow trout			165, 000	165, 000
	Steelhead trout			50, 000	50, 000
Meadow Creek, Mont.	Rainbow trout		275, 000	131, 500	406, 500
Yellowstone, Wyo.	Black-spotted trout	*8, 687, 400	1, 970, 100		10, 657, 500

Stations and substations operated and output of each, fiscal year 1923—Con.

Station and substation.	Species.	Eggs.	Fry.	Fingerlings, yearlings, and adults.	Total.
Cape Vincent, N. Y.	Brook trout		445,000		445,000
	Cisco	10,000,000	39,000,000		49,000,000
	Lake trout	*490,000	1,676,000		2,166,000
	Pike perch		600,000		600,000
	Rainbow trout		69,000		69,000
	Whitefish	*78,201,000	85,375,000		163,576,000
	Yellow perch		800,000		800,000
Central station, Washington, D. C.	Black bass			385	385
	Catfish			4,000	4,000
	Chinook salmon	5,000	5,000	10,000	20,000
	Crappie			450	450
	Humpback salmon		3,350	3,000	6,350
	Pike perch		750,000		750,000
	Rainbow trout			18,400	18,400
	Sunfish			24,100	24,100
	Whitefish			3,000	3,000
Bryans Point, Md.	Shad		16,771,000		16,771,000
	Yellow perch		128,525,000	210	128,525,210
Clackamas, Oreg.	Black-spotted trout			17,000	17,000
	Brook trout			17,000	17,000
	Chinook salmon	200,000	716,000	3,935,000	4,851,000
	Chum salmon			95,000	95,000
	Lake trout		25,000		25,000
	Rainbow trout			59,000	59,000
	Silver salmon			16,000	16,000
	Steelhead salmon	90,000		25,000	115,000
Applegate, Oreg.	Silver salmon			2,423,800	2,423,800
	Steelhead salmon	*1,095,000		1,200,000	2,295,000
Big White Salmon, Wash.	Chinook salmon			6,000,000	6,000,000
Little White Salmon, Wash.	do	*4,000,000		12,427,000	16,427,000
	Chum salmon			257,500	257,500
	Silver salmon			9,000	9,000
	Sockeye salmon			50,400	50,400
Rogue River, Oreg.	Black-spotted trout			15,500	15,500
	Chinook salmon			980,000	980,000
	Silver salmon			80,000	80,000
	Steelhead salmon			2,241,000	2,241,000
Salmon, Idaho	Brook trout			99,000	99,000
	Chinook salmon			1,124,700	1,124,700
	Rainbow trout			236,000	236,000
Sandy River, Oreg.	Black-spotted trout			2,600	2,600
	Chinook salmon			383,500	383,500
	Silver salmon			313,800	313,800
	Steelhead salmon	125,000		438,000	563,000
Washougal, Wash.	do	*434,000	260,000		694,000
Cold Springs, Ga.	Black bass		216,500	55,475	271,975
	Catfish			12,750	12,750
	Crappie			1,500	1,500
	Sunfish			90,400	90,400
Craig Brook, Me.	Atlantic salmon		451,000	40,038	491,038
	Brook trout		354,000	497,800	851,800
	Landlocked salmon	*76,872	223,000		299,872
Grand Lake, Me.	do	(*)	316,190	91,400	407,590
Green Lake, Me.	Brook trout		110,000		110,000
	Landlocked salmon		178,480		178,480
	Smallmouth black bass			94	94
	Smelt	17,030,000	28,000,000		45,030,000
Duluth, Minn.	Brook trout			135,000	135,000
	Lake trout	*525,000	13,170,000	85,000	13,780,000
	Pike perch		7,630,000		7,630,000
	Rainbow trout			86,000	86,000
	Steelhead salmon		15,000	75,000	90,000
	Whitefish		2,700,000		2,700,000
Edenton, N. C.	Black bass		25,000	28,175	53,175
	Catfish			575	575
	Crappie			120	120
	Glut herring		150,000,000		150,000,000
	Shad		200,000		200,000
	Sunfish			9,050	9,050
Weldon, N. C.	Striped bass		16,341,000		16,341,000
Erwin, Tenn.	Black bass		39,500	15,635	55,135
	Brook trout			278,200	278,200
	Rainbow trout	2,000		657,770	659,770
	Rock bass			18,050	18,050
	Smallmouth black bass			7,450	7,450
	Steelhead salmon			600	600
	Sunfish			4,645	4,645
	Yellow perch		500,000		500,000

Stations and substations operated and output of each, fiscal year 1923—Con.

Station and substation.	Species.	Eggs.	Fry.	Fingerlings, yearlings, and adults.	Total.
Fairport, Iowa	Black bass			8,160	8,160
	Buffalofish			96,575	96,575
	Carp			29,565	29,565
	Catfish			209,195	209,195
	Crappie			78,590	78,590
	Sunfish			205,630	205,630
	Miscellaneous			11,200	11,200
Gloucester, Mass	Cod	277,500,000	245,140,000		522,640,000
	Flounder		68,760,000		68,760,000
	Haddock	104,400,000	2,960,000		107,360,000
	Pollock	33,960,000	275,410,000		309,370,000
Homer, Minn	Black bass			127,030	127,030
	Buffalofish	35,055,000		24,593	35,079,593
	Carp	21,000,000		1,008,875	22,008,875
	Catfish			5,851,555	5,851,555
	Crappie			11,043,070	11,043,070
	Fresh-water drum			18,950	18,950
	Pike and pickerel			311,710	311,710
	Rock bass			1,010	1,010
	Sunfish			7,842,460	7,842,460
	White bass			20,580	20,580
	Yellow perch			529,840	529,840
	Miscellaneous			534,900	534,900
Atchafalaya, La	Buffalofish	128,114,500	5,925,000		134,039,500
	Fresh-water drum			3,000	3,000
Baton Rouge, La	Buffalofish			4,750	4,750
	Catfish			980	980
	Carp			885	885
	Crappie			10,600	10,600
	Fresh-water drum			1,500	1,500
	Sunfish			13,700	13,700
	White bass			425	425
	Miscellaneous			188,000	188,000
Bellevue, Iowa	Black bass			73,230	73,230
	Buffalofish			5,591,050	5,591,050
	Carp			7,244,120	7,244,120
	Catfish			4,463,080	4,463,080
	Crappie			6,653,375	6,653,375
	Fresh-water drum			194	194
	Pike and pickerel			21,270	21,270
	Sunfish			2,649,693	2,649,693
	Warmouth bass			80	80
	White bass			2,281	2,281
	Yellow perch			5,880	5,880
	Miscellaneous			7,838,132	7,838,132
La Crosse, Wis	Black bass			210,740	210,740
	Brook trout			242,600	242,600
	Buffalofish			3,000,135	3,000,135
	Carp			4,715,330	4,715,330
	Catfish			18,958,375	18,958,375
	Crappie			13,521,595	13,521,595
	Fresh-water drum			1,335	1,335
	Pike perch		2,100,000		2,100,000
	Pike and pickerel			484,815	484,815
	Rainbow trout			43,000	43,000
	Smallmouth black bass			94	94
	Sunfish			11,495,340	11,495,340
	White bass			7,002	7,002
	Yellow perch			346,315	346,315
	Miscellaneous			5,841,300	5,841,300
Marquette, Iowa	Black bass			94,555	94,555
	Buffalofish			473,490	473,490
	Carp			896,675	896,675
	Catfish			5,750,250	5,750,250
	Crappie			3,620,600	3,620,600
	Fresh-water drum			16,100	16,100
	Pike and pickerel			70,850	70,850
	Rock bass			300	300
	Sunfish			2,297,790	2,297,790
	White bass			1,200	1,200
	Yellow perch			50,055	50,055
	Miscellaneous			326,055	326,055
Rock Island, Ill	Black bass			5,125	5,125
	Buffalofish			105,595	105,595
	Carp			330,280	330,280
	Catfish			784,090	784,090
	Crappie			348,213	348,213
	Fresh-water drum			222	222
	Pike and pickerel			16,690	16,690

Stations and substations operated and output of each, fiscal year 1923—Con.

Station and substation.	Species.	Eggs.	Fry.	Fingerlings, yearlings, and adults.	Total.
Homer, Minn.—Contd.					
Rock Island, Ill. (Continued).	Sunfish			691,765	691,765
	White bass			777	777
	Yellow perch			4,525	4,525
	Miscellaneous			886,055	886,055
Simmesport, La	Black bass			239	239
	Buffalofish			22,550	22,550
	Catfish			1,298	1,298
	Carp			130	130
	Crappie			4,725	4,725
	Fresh-water drum			7,725	7,725
	Pike and pickerel			60	60
	Sunfish			3,400	3,400
	White bass			5,170	5,170
	Miscellaneous			192,500	192,500
Leadville, Colo	Black-spotted trout		120,000	551,000	671,000
	Brook trout	*725,000	315,000	3,030,000	4,070,000
	Lake trout			120,000	120,000
	Loch Leven trout			12,150	12,150
	Rainbow trout			64,000	64,000
	Steelhead trout			50,000	50,000
Louisville, Ky	Black bass			1,300	1,300
	Rock bass			1,750	1,750
	Smallmouth black bass		383,000	19,000	402,000
	Sunfish			26,800	26,800
Cairo, Ill	Black bass			150	150
	Buffalofish			22,600	22,600
	Catfish			755,000	755,000
	Crappie			307,000	307,000
	Sunfish			123,000	123,000
Mammoth Spring, Ark.	Black bass			87,500	87,500
	Crappie			400	400
	Rock bass			17,600	17,600
	Smallmouth black bass			20,200	20,200
	Sunfish			14,000	14,000
Manchester, Iowa	Brook trout			445,545	445,545
	Rainbow trout	*2,000		98,685	100,685
	Rock bass			5,750	5,750
Nashua, N. H	Brook trout			614,106	614,106
	Lake trout			21,000	21,000
	Landlocked salmon			1,400	1,400
	Pike perch		75,000		75,000
	Rainbow trout			39,700	39,700
	Smallmouth black bass		8,700		8,700
Neosho, Mo	Black bass			9,038	9,038
	Crappie			600	600
	Rainbow trout	746,460		258,065	1,004,525
	Rock bass			4,415	4,415
	Smallmouth black bass			38	38
	Sunfish			17,521	17,521
	Yellow perch	3,680,000	3,500,000	270	7,180,270
Northville, Mich	Brook trout		110,000	197,000	307,000
	Lake trout		20,000		20,000
	Rainbow trout			15,000	15,000
	Smallmouth black bass		30,700	32,325	63,025
Alpena, Mich	Lake trout	*1,958,000	610,000		2,568,000
	Whitefish	*17,440,000	600,000		18,040,000
Charlevoix, Mich	Lake trout	4,250,000	19,000,000		23,250,000
	Landlocked salmon		10,000		10,000
	Whitefish	(*)	20,000,000		20,000,000
Orangeburg, S. C	Black bass		101,000	299,146	400,146
	Catfish			180	180
	Sunfish			26,030	26,030
	Warmouth bass			8,200	8,200
Put in Bay, Ohio	Carp	8,000,000	115,000,000		123,000,000
	Pike perch	*37,275,000	51,800,000		89,075,000
	Whitefish	*52,400,000	100,000,000		152,400,000
	Yellow perch		3,000,000		3,000,000
Quinault, Wash	Black-spotted trout		45,000		45,000
	Sockeye salmon			944,000	944,000
	Steelhead salmon			78,000	78,000
St. Johnsbury, Vt	Brook trout	300	956,000	274	956,574
	Lake trout	*300	151,969		152,269
	Steelhead salmon			8,000	8,000
Holden, Vt	Brook trout		238,400	9,050	247,450
	Lake trout	30,000	95,446	6,500	131,946
	Rainbow trout			1,200	1,200
	Steelhead salmon			300	300
York Pond, N. H	Brook trout			1,264	1,264
	Lake trout			80	80

Stations and substations operated and output of each, fiscal year 1923—Con.

Station and substation.	Species.	Eggs.	Fry.	Fingerlings, yearlings, and adults.	Total.
San Marcos, Tex.	Black bass			251,918	251,918
	Crappie			4,310	4,310
	Rock bass			260	260
	Sunfish			14,508	14,508
	Warmouth bass			70	70
Saratoga, Wyo.	Black-spotted trout			87,500	87,500
	Brook trout			138,100	138,100
	Rainbow trout	619,440		103,800	723,240
Lost Creek, Wyo.	do		410,000		410,000
Spearfish, S. Dak.	Brook trout			792,445	792,445
	Loch Leven trout	(*)		31,650	31,650
	Rainbow trout			35,360	35,360
Springville, Utah	Black-spotted trout			1,600	1,600
	Brook trout			282,450	282,450
	Rainbow trout	*5,000		357,000	362,000
Tupelo, Miss.	Black bass		337,000	75,190	412,190
	Crappie			650	650
	Sunfish			80,100	80,100
Friar Point, Miss.	Black bass			6,960	6,960
	Buffalofish			88,500	88,500
	Carp			300	300
	Catfish			314,285	314,285
	Crappie			8,399	8,399
	Rock bass			2,145	2,145
	Sunfish			1,221,000	1,221,000
	White bass			2,650	2,650
White Sulphur Springs, W. Va.	Black bass		87,500	2,680	90,180
	Brook trout			710,066	710,066
	Rainbow trout	*1,047,500		726,900	1,774,400
	Rock bass			930	930
	Smallmouth black bass		27,000		27,000
	Sunfish			1,250	1,250
Woods Hole, Mass.	Cod	*373,480,000	131,673,000		505,153,000
	Flounder	229,345,000	123,221,000		352,566,000
	Pollock		688,000		688,000
	White perch			675	675
Wytheville, Va.	Black bass			5,875	5,875
	Brook trout			257,750	257,750
	Catfish			2,000	2,000
	Rainbow trout	*243,000		168,100	411,100
	Rock bass			12,700	12,700
	Sunfish			5,250	5,250
Yes Bay, Alaska	Humpback salmon		393,600		393,600
	Sockeye salmon		1,500,000	18,500,000	20,000,000
Gross output		1,464,480,872	2,586,887,790	264,489,063	4,315,857,725
Loss in transit		750,440	75,500	172,756	998,696
Net output		1,463,730,432	2,586,812,290	264,316,307	4,314,859,029

Transfers of eggs between stations, fiscal year 1923.

Species.	Number of eggs.	From—	To—
Black-spotted trout	75,000	Yellowstone Park, Wyo.	Clackamas, Oreg.
	1,332,000	do	Glacier Park, Mont.
	698,000	do	Leadville, Colo.
	50,000	do	Quinault, Wash.
	100,000	do	Saratoga, Wyo.
Brook trout	131,666	Craig Brook, Me.	Grand Lake Stream, Me.
	500,000	Leadville, Colo.	Bozeman, Mont.
	531,300	Springville, Utah	Do.
	230,000	do	Clackamas, Oreg.
	259,200	do	La Cross, Wis.
	259,200	do	Manchester, Iowa.
	26,400	do	Salmon, Idaho.
	259,200	do	Spearfish, S. Dak.
Chinook salmon	225,000	Little White Salmon, Wash.	Central station, Washington, D. C.
	1,750,000	do	Clackamas, Oreg.
Chum salmon	5,501,000	Brinnon, Wash.	Duckabush, Wash.
	1,800,000	do	Quilcene, Wash.
Cod	30,480,000	Woods Hole, Mass.	Gloucester, Mass.
Humpback salmon	278,616	Afognak, Alaska	Birdsview, Wash.
	50,000	Birdsview, Wash.	Central station, Washington, D. C.

Transfers of eggs between stations, fiscal year 1923—Continued.

Species.	Number of eggs.	From—	To—
Lake trout	50,000	Cape Vincent, N. Y.	Holden, Vt.
	75,000	Duluth, Minn.	Bozeman, Mont.
	25,000	do	Clackamas, Oreg.
	150,000	do	Leadville, Colo.
	108,000	Northville, Mich.	Alpena, Mich.
	3,037,000	Alpena, Mich.	Charlevoix, Mich.
	230,000	do	Northville, Mich.
	3,000,000	Charlevoix, Mich.	Alpena, Mich.
	4,000,000	do	Cape Vincent, N. Y.
	6,000,000	do	Duluth, Minn.
	50,052	St. Johnsbury, Vt.	Nashua, N. H.
Landlocked salmon	20,349	Craig Brook, Me.	Do.
	20,349	do	St. Johnsbury, Vt.
	380,602	Grand Lake Stream, Me.	Craig Brook, Me.
Loch Leven trout	10,350	Spearfish, S. Dak.	St. Johnsbury, Vt.
Pike perch	500,000	Put in Bay, Ohio	Berkshire, Mass.
	1,500,000	do	Cape Vincent, N. Y.
	1,000,000	do	Central station, Washington, D. C.
	1,500,000	do	Nashua, N. H.
Rainbow trout	50,000	Bozeman, Mont.	Neosho, Mo.
	25,000	do	Manchester, Iowa.
	77,000	Manchester, Iowa.	La Crosse, Wis.
	25,000	Springville, Utah	Manchester, Iowa.
	50,000	White Sulphur Springs, W. Va.	Nashua, N. H.
	50,000	Wytheville, Va.	Central station, Washington, D. C.
	50,000	do	Craig Brook, Me.
	50,000	do	Nashua, N. H.
Silver salmon	3,025,000	Baker Lake, Wash.	Birdsview, Wash.
	780,000	Birdsview, Wash.	Duckabush, Wash.
	650,000	Sultan, Wash.	Quilcene, Wash.
Sockeye salmon	25,000	Baker Lake, Wash.	Birdsview, Wash.
Steelhead salmon	100,000	Applegate, Oreg.	Duluth, Minn.
	100,000	do	Leadville, Colo.
	85,000	do	Trail, Oreg.
	50,000	Washougal River, Wash.	Bozeman, Mont.
	35,000	do	Clackamas, Oreg.
	50,000	do	St. Johnsbury, Vt.
	50,000	do	Spearfish, S. Dak.
Whitefish	1,120,000	Cape Vincent, N. Y.	Central station, Washington, D. C.
	35,935,000	Alpena, Mich.	Charlevoix, Mich.
	200,000	do	Northville, Mich.
	1,000,000	Put in Bay, Ohio	Central station, Washington, D. C.
	20,000,000	Charlevoix, Mich.	Alpena, Mich.
Yellow perch	9,165,000	Bryans Point, Md.	Central station, Washington, D. C.
	750,000	Central station, Washington, D. C.	Erwin, Tenn.
	250,000	do	Wytheville, Va.

EGG-COLLECTING OR AUXILIARY STATIONS.

In many instances the eggs hatched at the main stations are obtained at points established as near as possible to the base of egg-collecting operations. All of these egg-collecting auxiliaries are temporary in character, many of them being mere camps with a tent for the operator to live in, which in many instances serves also as a place where the eggs may be packed for shipment. In other fields the operator may be quartered with the fishermen or at some hotel in the vicinity, in which case a fish house is used for packing operations. During the past fiscal year 75 of these egg-collecting stations were occupied for periods varying from two weeks to approximately three months. The following list of substations of this class shows in each case the main station from which operations were conducted, the period of operation, and the species handled.

Egg-collecting stations, period of operation, and species handled, fiscal year 1923.

Station.	Period of operation.	Species handled.
Boothbay Harbor, Me.:		
Casco Bay, Me	Mar. 14 to May 7	Winter flounder.
Ebenecook Harbor, Me	Mar. 10 to May 1	Do.
Johns Bay, Me	Mar. 10 to May 10	Do.
Linekins Bay, Me	Feb. 27 to May 11	Do.
Outer Penobscot Bay	Mar. 16 to May 10	Do.
Seal Harbor, Me	do	Do.
Southport Coves, Me	Feb. 27 to May 19	Do.
Townsend Gut, Me	Mar. 10 to May 10	Do.
Cape Vincent, N. Y.:		
Bygotts Point, Ontario	Nov. 1 to Dec. 1	Cisco, whitefish.
Chaumont Bay, N. Y	Nov. 12 to Dec. 8	Do.
Deseronto, Ontario	Nov. 1 to Dec. 1	Do.
Fairhaven Bay, N. Y	Nov. 25 to Dec. 9	Cisco.
Grass Bay, N. Y	May 1 to 16	Yellow perch.
Pigeon Island, Ontario	Oct. 17 to Nov. 12	Lake trout.
Sodus Bay, N. Y	Nov. 25 to Dec. 8	Cisco.
South Bay, Ontario	Nov. 12 to 24	Whitefish.
Clackamas, Oreg.:		
Lemhi, Idaho	June to September	Chinook salmon.
Pahsimeroi, Idaho	September to October	Do.
Sunbeam Dam, Idaho	do	Do.
Craig Brook, Me.:		
Dobsis Lake, Me	Oct. 21 to Nov. 14	Landlocked salmon.
Ox Brook, Me	Oct. 21 to 23	Do.
Duluth, Minn.:		
Au Train, Mich	Oct. 16 to Nov. 3	Lake trout.
Bete Grise, Mich	Oct. 19 to Nov. 8	Do.
Fish Island, Mich	Oct. 18 to Nov. 25	Lake trout, whitefish.
Fishermens Home, Mich	do	Do.
Gay, Mich	Oct. 19 to Nov. 8	Lake trout.
Grand Marais, Mich	Oct. 20 to Nov. 5	Do.
Huron Island, Mich	Oct. 19 to Nov. 8	Do.
Keystone, Mich	Oct. 12 to Nov. 6	Do.
Long Point, Mich	Oct. 18 to Nov. 25	Lake trout, whitefish.
Manitou Island, Mich	Oct. 19 to Nov. 8	Lake trout.
Marquette, Mich	Oct. 17 to Nov. 9	Do.
Munising, Mich	Oct. 16 to Nov. 3	Do.
Ontonagon, Mich	Oct. 20 to Nov. 6	Do.
Portage Entry, Mich	Oct. 19 to Nov. 8	Do.
Portage Lake Canal, Mich	Oct. 20 to 31	Do.
Rock Harbor, Mich	Oct. 18 to Nov. 25	Lake trout, whitefish.
Siscowit Bay, Mich	do	Do.
Tobens Harbor, Mich	do	Do.
Todds Harbor, Mich	do	Do.
Traverse Bay, Mich	Oct. 19 to Nov. 8	Lake trout.
Washington Harbor, Mich	Oct. 18 to Nov. 25	Do.
Wrights Island, Mich	do	Do.
Leadville, Colo.:		
Carroll Lake, Colo	Oct. 29 to Nov. 18	Brook trout.
Engelbrecht Lake, Colo	Sept. 24 to Nov. 26	Do.
Fred Neal Lake, Colo	Nov. 17 to 26	Do.
Musgroves Lake, Colo	Oct. 26 to Nov. 22	Do.
Turquoise Lake, Colo	Oct. 19 to Nov. 29	Do.
Neosho, Mo.:		
Roaring River, Mo	Nov. 5 to Feb. 13	Rainbow trout.
Northville, Mich.:		
Cheboygan, Mich	Oct. 22 to 31	Lake trout.
Fairport, Mich	Oct. 26 to Dec. 2	Do.
Frankfort, Mich	Nov. 3 to 23	Do.
Gould City, Mich	Nov. 18 to 27	Whitefish.
Leeland, Mich	Nov. 3 to 21	Lake trout.
Manistique, Mich	Oct. 22 to Nov. 16	Do.
Naubinway, Mich	Nov. 18 to 27	Whitefish.
Northport, Mich	Nov. 1 to 21	Lake trout.
St. Ignace, Mich	Oct. 22 to Nov. 27	Do.
St. James, Mich	Nov. 1 to 22	Lake trout, whitefish.
Put in Bay, Ohio:		
Catawba Island, Ohio	Nov. 12 to Dec. 4	Whitefish.
Middle Bass Island, Ohio	Nov. 12 to Dec. 8	Do.
North Bass Island, Ohio	Nov. 8 to Dec. 8	Do.
	Apr. 15 to 30	Pike perch.
Pelee Island, Ontario	Nov. 28 to Dec. 4	Whitefish.
Port Clinton, Ohio	Nov. 1 to Dec. 4	Do.
	Apr. 12 to June 24	Pike perch.
Toledo, Ohio	Nov. 8 to 30	Whitefish.
	Apr. 15 to May 8	Pike perch.
St. Johnsbury, Vt.:		
Darling Pond, Vt	October and November	Brook trout.
Lake Dunmore, Vt	Oct. 25 to Nov. 5	Lake trout.
Lake Mitchell	October and November	Brook trout.

Egg-collecting stations, period of operation, and species handled, fiscal year 1923—Continued.

Station.	Period of operation.	Species handled.
Saratoga, Wyo.:		
Big Creek Lake, Wyo	October and November	Brook trout.
Canon Creek, Wyo	April to June	Rainbow trout.
Sage Creek, Wyo	do	Do.
Springville, Utah:		
Fish Lake, Utah	Nov. 3 to 28	Brook trout.
	May 2 to June 4	Rainbow trout.
Woods Hole, Mass.:		
Sandwich, Mass	Nov. 1 to Dec. 31	Cod.
Waquoit, Mass	Jan. 18 to Mar. 15	Winter flounder.
Wickford, R. I	Mar. 16 to Apr. 5	Do.

FISH FOOD USED AT HATCHERIES.

The following table indicates the amounts and kinds of food used at the fish-cultural stations of the bureau during 1923, with the cost per pound of each material used.

Pounds and cost per pound of fish food used during the fiscal year 1923.

PACIFIC SALMON STATIONS.

Station.	Beef liver.		Sheep liver.		Beef melts.		Canned salmon.	
	Pounds.	*Cost.*	*Pounds.*	*Cost.*	*Pounds.*	*Cost.*	*Pounds.*	*Cost.*
Baird and substations, Calif	1,112	$0.10						
Baker Lake and substations, Wash	1,270	.0634	676	$0.08	3,360	$0.045	{1 1,008 / 1 4,210}	$0.06
Clackamas and substations, Oreg	770	.05			6,221	.039		
Total	3,152		676		9,581		5,218	

Station.	Salted salmon.		Fresh fish.		Salmon eggs.		Middlings.	
	Pounds.	*Cost.*	*Pounds.*	*Cost.*	*Pounds.*	*Cost.*	*Pounds.*	*Cost.*
Afognak, Alaska	2,450	$0.0454	[2] 300					
Yes Bay, Alaska	1,725	.02			1,700	$0.015		
Baird and substations, Calif	9,000	.025						
Baker Lake and substations, Wash	{1 1,313 / 1 250}	.0215	[2] 120					
Clackamas and substations, Oreg	10,000	.011			4,420	.044	200	$0.028
Total	24,738		420		6,120		200	

ROCKY MOUNTAIN TROUT STATIONS.

Station.	Beef liver.		Beef hearts.		Sheep liver.		Hog liver.		Sheep plucks.	
	Pounds.	*Cost.*	*Pounds.*	*Cost.*	*Pounds.*	*Cost.*	*Pounds.*	*Cost.*	*Pounds.*	*Cost.*
Bozeman and substations, Mont	5,910	$0.075					6,883	$0.06		
Leadville, Colo			2,676	$0.0375						
Saratoga, Wyo	1,124	.05	1,754	.0425	550	$0.0425				
Spearfish, S. Dak	322	.12	1,146	.105	2,197	.07			2,200	$0.06
Springville, Utah	2,829	.04	9,594	.05	4,367	.06				
Total	10,185		15,170		7,114		6,883		2,200	

[1] Donated by State fish and game commission. [2] No cost.

Pounds and cost per pound of fish food used during the fiscal year 1923—Con.

ROCKY MOUNTAIN TROUT STATIONS—Continued.

Station.	Paxton fish food.		Fishotine.		Lean beef.		Fresh fish.		Low-grade flour.	
	Pounds.	*Cost.*	*Pounds.*	*Cost.*	*Pounds.*	*Cost.*	*Pounds.*	*Cost.*	*Pounds.*	*Cost.*
Spearfish, S. Dak	39	$0.06	24	$0.08	14	$0.20				
Springville, Utah							6,225	$0.125	9,630	$0.0225
Total	39		24		14		6,225		9,630	

NEW ENGLAND TROUT AND SALMON STATIONS.

Station.	Beef liver.		Beef heart.		Sheep liver.		Pork liver.		Beef melts.	
	Pounds.	*Cost.*	*Pounds.*	*Cost.*	*Pounds.*	*Cost.*	*Pounds.*	*Cost.*	*Pounds.*	*Cost.*
Berkshire trout hatchery, Mass	364	$0.08							2,426	$0.05
Craig Brook, Me	892	.08					526	$0.06		
Nashua, N. H	1,149	.065	50	$0.045	3,274	$0.0425				
Total	2,405		50		3,274		526		2,426	

STATIONS PROPAGATING BOTH TROUTS AND POND FISHES.

Station.	Beef liver.		Beef heart.		Sheep liver.		Middlings.		Low-grade flour.	
	Pounds.	*Cost.*	*Pounds.*	*Cost.*	*Pounds.*	*Cost.*	*Pounds.*	*Cost.*	*Pounds.*	*Cost.*
Erwin, Tenn			5,580	$0.057	9,815	$0.0485	2,100	$0.0197	294	$0.027
Manchester, Iowa			3,182	.04	12,840	.036	400	.0175		
Neosho, Mo	1,684	$0.033	959	.0435	4,610	.0384	1,500	.016	3,705	.035
White Sulphur Springs, W. Va	113	.05	7,584	.05	20,036	.0471				
Wytheville, Va	4,609	.05	6,692	.06						
Total	6,406		23,997		47,301		4,000		3,999	

POND FISH-CULTURAL STATIONS.

Station.	Beef liver.		Beef heart.		Fresh fish.		Fishotine.		Middlings.	
	Pounds.	*Cost.*	*Pounds.*	*Cost.*	*Pounds.*	*Cost.*	*Pounds.*	*Cost.*	*Pounds.*	*Cost.*
Cold Springs, Ga., and substations					5,087	$0.10	373	$0.07	420	$0.10
Edenton, N. C	37	$0.20			172	.125				
Louisville, Ky	116	.10	437	$0.10						
Mammoth Spring, Ark			1,464	.052						
Orangeburg, S. C			1,864	.10						
Tupelo, Miss			1,688	.0926						
Total	153		5,453		5,259		373		420	

HATCHERY FISH-CULTURAL NOTES.

METHOD OF PREPARING FOOD FOR YOUNG SALMON.

In connection with the salmon-rearing operations at the Oregon station and substations, considerable quantities of immature salmon eggs are used as a fish food with very satisfactory results. This spawn is taken in immense quantities in the commercial fisheries of the Columbia River and is held in cold storage until needed, when it is thawed by immersion in cold water. In preparing the material for food it is first passed through the coarse plate of a meat chopper and is then cooked in a single boiler for about 2½

hours, during which time it is stirred constantly. When cooked the food resembles granulated yellow cornmeal, and when introduced into the ponds and troughs it does not discolor the water.

TEST OF COPPER SULPHATE FOR ERADICATION OF FUNGUS.

The great difficulty experienced in preventing the development and growth of fungus on crappie held for distribution during the summer months impelled the district supervisor in charge of the Mississippi River rescue work to test the copper-sulphate treatment in an effort to find a cure for the trouble. Owing to the extreme weakness of very small crappie and sunfish in intensely warm weather, it was found that they would not survive even a weak solution of the chemical, those used in the test perishing in large numbers when subjected to it. The results demonstrated that it might be successfully applied to fishes of larger growth and to the stronger individuals among the younger fishes, and also that it is valuable for disinfecting and cleaning the troughs in which fish are held. Its use for such purposes will hereafter be resorted to at the holding and distributing stations in the rescue fields.

In this connection too much stress can not be laid upon the need for exercising care in the handling of fish to avoid abrasions, which serve as avenues of access for bacteria. In landing seines in the rescue fields special effort is made to prevent hauling the fish over low muddy places, thus filling the gills with mud. For the infection work, also, only the larger and stronger fishes are selected as hosts, all small and weak specimens being carefully culled out.

PARASITIC AFFECTION IN WHITEFISH JARS.

In connection with the parasitic affection that caused so much trouble in the whitefish jars at the Cape Vincent (N. Y.) station during the past season, it is the opinion of the bureau that the heavy losses sustained were very largely the result of the additional handling required in order to remove the growth from the jars. In investigating the underlying causes of a heavy loss of shad eggs at Windsor, Conn., Doctor Mitchell, of Brown University, found that a very large percentage of the loss was due not to lack of fertilization but to scratches and abrasions on the surface of the eggs. The raw surfaces caused by the abrasions formed a fertile ground for the multiplication of bacteria, and later on a white mold appeared, quickly coating the eggs. It is quite possible that the heavy mortality experienced in the incubation of whitefish and cisco eggs may be traced to injuries to the shell, many of them being caused by the constant screening and washing of the eggs. This may also explain the higher percentage of hatch attained by fishery employees of the State when using an inverted funnellike bottom on their jar tubes. The effect of this arrangement is to spread out the intake flow of water, thus imparting a slow movement to the eggs. When eggs in circulation are thrown violently against the jar bottoms they are liable to become more or less scratched, especially if the jars contain particles of iron rust, which is often the case. Heavy losses of brook-trout eggs have frequently been noted when they are massed during the expansion period. In the process of separating the eggs

the protecting film of the shell is apt to be broken, forming a fertile field for bacterial growth. It is believed this subject is worthy of careful study in an effort to overcome the heavy losses of eggs annually occurring at most of the stations of the bureau.

HATCHING EGGS IN GRAVEL.

Some interesting experiments in the hatching of trout eggs in gravel were conducted in the course of the year at the Wytheville (Va.) station. On January 4, 6,600 eyed rainbow-trout eggs were buried in sand and gravel in one of the rearing ponds. This material was obtained from a neighboring creek and was not screened, though the larger stones were removed. No fish having been observed by February 27, the covering was removed and washed and all the eggs were found to be dead.

In another experiment, undertaken on January 5, a trough was prepared with crushed stone sifted through a coarse-mesh screen to exclude the fine particles. Four nests were made with the larger pieces of stone, and in each of these eyed eggs to the number of 944 were scattered and covered to a depth of about 3 inches with the sifted material. A few fry in the advanced stage were observed in the trough on February 10, and the remainder of the hatch came out of the nests within the next two weeks with the sac nearly absorbed. On February 20, when the nests were removed and the fingerlings counted, it was ascertained that 2,736 of the 3,736 eggs planted had hatched.

COMMERCIAL FISHES.

Of the 71 stations and substations engaged in the fish-cultural operations of the bureau, the work of 44 was devoted mainly to propagation and to the salvage of certain commercial species. Among the most important fishes handled, from a commercial viewpoint, were the salmons of the Pacific coast, the whitefishes, lake trout, and cisco of the Great Lakes, and the cod, haddock, pollock, and winter flounder of the Atlantic coast. Other species of lesser commercial value were handled on a smaller scale. The results of the work at these stations show a considerable decrease as compared with those of the previous year, most of the falling off occurring among the Atlantic coast species. The principal reason for the decline was the unusually severe weather prevailing during the spawning period, though lack of funds for the efficient prosecution of the work at all points was also responsible in some degree.

PACIFIC SALMONS.

Fish-cultural operations coming under this head are conducted extensively at 19 stations and substations located in Washington, Oregon, California, and Alaska. Operations at this group of stations are devoted almost exclusively to the propagation of the salmons of the Pacific coast, though small numbers of trout eggs, transferred from other stations of the bureau, are usually hatched annually at two or three points in Oregon to supply the local demands for fish of that character. The results attained in the salmon work during

the year were fairly satisfactory, though the output of the stations in this class was somewhat smaller than that of the preceding year.

AFOGNAK (ALASKA) STATION.

[F. R. Lucas, Superintendent.]

The steady annual increase in the run of sockeye salmon to waters in the vicinity of the Afognak station, frequent mention of which has been made in previous reports, was maintained throughout the past year. Not only were the egg collections larger than in 1922, but fully half the fish counted into Letnik Lake could not be utilized in the propagation work owing to lack of facilities for handling the spawn. This gratifying situation is believed to be due solely to the bureau's efforts to build up and improve the run.

The spawning operations were begun August 1 and extended to the middle of September, by which time a sufficient number of eggs had been obtained to severely tax the fry-holding capacity of the station, the total amounting to 61,790,000, or nearly 8,000,000 in excess of last year's collection. During the month of September 10,678,400 eyed eggs were shipped in charge of an attendant, part of them being delivered at Juneau, Alaska, to fill the application of the fisheries commission of that Territory; approximately half a million were furnished to the fisheries authorities of the State of Washington, and the remainder was turned over to the Oregon State hatchery at Bonneville. From the eggs incubated at the station 47,569,000 fry, or 93 per cent of those retained, were produced, the hatching period extending from October 15 to April 25. All fry were held on trays until the sac was absorbed, when many of them had to be liberated as the rearing capacity under the present stacked-tray system is sufficient for only about 30,000,000. Those retained for rearing were held in open troughs and liberated from time to time, the last of them being disposed of shortly before the end of the fiscal year.

In response to a request from the Birdsview (Wash.) station for a consignment of humpback-salmon eggs, a collection of 600,000 of this species was made on August 23. Approximately 278,000 were shipped to that point in the eyed stage, and from the remainder 240,000 fry were produced and liberated in the fingerling stage in one of the branches of Letnik River.

A disquieting feature connected with the propagation work in this region is the presence of the Dolly Varden trout in large numbers. It has been conclusively demonstrated that these fish constitute a serious menace to the welfare of young salmon, which they have been observed to follow in their downstream migrations in May and June, returning with the run of brood salmon in July and later. A dam was recently constructed across Letnik River with the view of excluding this species and other undesirable fishes from Letnik Lake, which it is desired to retain exclusively for the sockeye work. As a result of the systematic attempts made to reduce the numbers of Dolly Varden trout, between six and seven thousand were captured during the year in seines and traps. Their flesh was used, so far as it was needed, for feeding the fingerling salmon.

In the course of the year a number of minor repairs were made to station buildings, roads, equipment, and vessels. A 32-volt, 850-watt Delco lighting system, equipped with storage batteries, was purchased and installed in an insulated room for furnishing light to the various buildings. A one-half-kilowatt radio transmitting set was also purchased and installed in one of the rooms in the bunk house. This set is capable of sending on a 300, 420, or 600-meter wave length, and has ample power to permit of communication with the naval radio station at Kodiak. A 5,000-meter crystal detector receiving set was also provided.

Most of the trays used in the stacked-tray system at this station are 1 inch high and are used in the troughs in stacks of four—three filled ones with an empty one at the top. As an experiment 1,000 trays three-fourths inch high with mitered corners were constructed, and were placed four filled trays to a stack. They were found to work just as successfully as the deeper ones, and by their use the capacity of a fry-holding trough is increased one-third.

YES BAY (ALASKA) STATION.

[JOHN W. GARDNER, Superintendent.]

The fish-cultural work at this important salmon hatchery during the fiscal year 1923 may be considered satisfactory. Notwithstanding the short egg-collecting period, which extended from September 5 to September 22, sockeye-salmon eggs to the number of 25,000,000 were taken, and approximately 500,000 eggs of the humpback salmon were obtained incidentally. On September 22 the fishing racks were wrecked by heavy drift washed against them during a sudden rise in the river. The collecting season was thus abruptly ended, though spawning fish in considerable numbers were ascending the river then and for some time afterwards.

For the first time since the general adoption of stacked trays for holding salmon fry through the yolk-sac absorption period a complaint has been registered against the system. The superintendent of the Yes Bay station reports that during the year a loss in excess of 29 per cent occurred among the fish thus held, while the death rate among the fry held in troughs was merely nominal. He attributes the abnormal loss to an unusual condition of the water supply; at least such a condition had never been observed previously at the station. He states that circulation was almost entirely precluded at times by the presence of quantities of slime, which covered the frames and wires of the trays, forming a jellylike substance. This slime is supposed to have come from the swampy tundra of the surrounding region. The superintendent suggests that the trouble might be overcome by the removal of the 14-inch mesh from the trays and the substitution of 10 or 12-inch mesh.

The year's output of the station consisted of 20,000,000 sockeye salmon, all but 1,500,000 being fingerlings No. 1; also humpback salmon fry to the number of 393,600, and upward of 4,000,000 sockeye fingerlings remained in the troughs at the end of the year.

Approximately 6,500,000 sockeye fingerlings were placed in McDonald Slough, an inclosed arm of Yes Lake about 4 acres in area, which has been used for several seasons as a rearing pond. Before

placing the fingerlings in this inclosure all other fish that may have collected therein are removed with seines and gill nets and the entrance is screened to prevent their return. The salmon may then be given artificial food in addition to the natural food in the water, and held until such time as it seems desirable to release them.

During the winter months further trouble was experienced from anchor ice, and it appears important that steps be taken to correct this condition and thus avoid the threatened loss of valuable stock each season. During extended periods of cold the water at the intake end of the pipe line falls to a level where the pipe does not carry water to its full capacity. At such times anchor ice causes trouble, and there is always danger of the line freezing completely. Should this occur it would in all probability entail not only the loss of all eggs or fish on hand but it would be liable also to seriously damage the pipe line. As a corrective measure the superintendent recommends certain alterations to the dam at the intake, including an increase of its height to deepen the water at that point, and the protection of the pipe against frost by covering it throughout its entire length.

BAKER LAKE (WASH.) STATION AND SUBSTATIONS.

[J. R. RUSSELL, Superintendent.]

Satisfactory results were achieved in the fish-cultural work in this field during the fiscal year, the egg collections and output of fish eggs and young fish from all points comparing favorably with the work of past years, while the egg collections and output exceeded those of the preceding year by a substantial margin.

In this connection it should be taken into consideration that the Quinault station, which for some years has been an auxiliary of the Baker Lake station, is now being operated under the direction of an independent superintendent, and its output does not enter into the total of the Washington group of stations. A review of the year's work in the Quinault field is contained on page 29 of this report.

The Baker Lake field involves the work of six stations, all in the State of Washington, with the headquarters of the superintendent at Birdsview. Fish-cultural work in 1923 was addressed to the five species of Pacific coast salmon and the steelhead. Though the humpback salmon does not figure in the year's egg collections, the species is represented in the output by upward of 1,500,000 of advanced fry, these being the progeny of eggs collected in Alaska waters by employees of the State of Washington, and of a smaller shipment of eggs transferred from the bureau's Afognak station. These transfers were made with the view of effecting, if possible, the reestablishment of an annual run of humpback salmon in Puget Sound waters.

BAKER LAKE (WASH.) STATION.

Though it has been found more convenient in recent years to maintain executive headquarters at Birdsview, Baker Lake has always been considered the main station of the Washington group. It is the point at which the bureau first attempted fish-cultural work in the State of Washington, and it has continued to be the most im-

portant station as regards the value of its work to the great salmon industry of the surrounding region.

The construction work at this point during the year included the remodeling and rebuilding of the stable, some needed alterations and repairs to fishing and spawn-taking appliances at the retaining inclosure, and repairs to the trap. The trail and telephone line between the station and the railroad at Concrete, Wash., was kept open throughout the year. Because of the expense involved in packing supplies to this station from the railroad line, 18 miles distant, it has been found profitable to do a considerable amount of farming. Several acres of land adjacent to the buildings are under cultivation, and from this land upward of 6 tons of hay and a sufficient amount of vegetables to supply the station mess were produced. A storm channel was excavated for the diversion of flood waters from the creek flowing through the station grounds into a deep ravine, thus relieving the station of a flood menace of long standing.

There were on hand at the first of the year 5,400,000 sockeye-salmon fingerlings, all of which were distributed in July, 1922. From the operation of the trap at the outlet of the lake 7,080 adult sockeye salmon were taken between July 1 and August 14, and were held in the inclosure with the usual success until ready to spawn, all of them remaining in splendid condition throughout the period of confinement. Spawn taking was in progress almost daily from October 1 to November 21, and 11,040,000 eggs of excellent quality were obtained from the 3,499 female fish contained in the brood stock.

During the run of silver salmon—from September 25 to November 18—adult fish to the number of 2,924 were taken. Low water stages in Baker River were detrimental to the work, as large numbers of fish were unable or unwilling to ascend the shallow stretches of the river and deposited their eggs far below the usual spawning places. Between October 31 and December 15 the 1,033 females in the lot yielded 3,115,000 eggs. After being eyed, all of these were transferred to the Birdsview station for incubation.

In contrast to the statement of the superintendent of the Yes Bay station with reference to the use of stacked trays for rearing sockeye-salmon fry, the following is quoted from the annual report of the superintendent of the Baker Lake station:

> The fry were thoroughly cleaned when taken from under the baskets and were then placed on the trays, where they remained without further attention, aside from the regulation of the water, until they were swimming up. This would seem to indicate that if the fry are healthy when placed on the trays there is no need to molest them during the sac-absorption period, provided, of course, that no unfavorable water or other conditions are encountered.

Besides the 3,025,000 eyed silver-salmon eggs transferred to the Birdsview station, the distribution from Baker Lake included 15,175,000 sockeye-salmon fingerlings, with some 700,000 remaining on hand at the end of the year.

BIRDSVIEW (WASH.) SUBSTATION.

At the beginning of the chinook-salmon spawning season in September the protracted dry weather had reduced the water stages in Grandy Creek to such an extent that successful fish-cultural work seemed impossible. Late in October, however, the greatly needed

rains came, bringing the streams to normal level, and from that date on conditions were generally favorable to good work. The egg collections were therefore successful, and more fish were produced for distribution than for a number of seasons past.

Between September 30 and October 4, while the drought still prevailed, 38,000 chinook-salmon eggs and more than 4,000,000 silver-salmon eggs were taken, the collecting season extending from October 4 to December 22. The steelhead work at this point also showed a satisfactory improvement over that of last season, the collections netting 847,000 eggs of excellent quality. No humpback salmon were in evidence in Grandy Creek during the year, but in October approximately 275,000 eggs of this species were received from the Afognak station. A small number was sent to central station at Washington, D. C., for exhibition, while the remainder was incubated and the young fish liberated locally in continuance of the policy of attempting the reestablishment of the run of humpback salmon in Puget Sound waters during the so-called "off year." No chum-salmon eggs were handled at the station during the year and no fish of this species were taken in the Grandy Creek trap, but it was observed that there was an excellent run in the Skagit River, large numbers of them appearing on the spawning grounds and apparently in excellent condition.

The output of all species of fish from this station amounted to 8,107,890 fry and fingerlings, and upward of 1,000,000 remained in the ponds and troughs at the close of the year.

BRINNON (WASH.) SUBSTATION.

This field station was opened on November 2 for the collection of eggs of the late run of chum salmon. During the spawning season—from December 4 to January 8—eggs to the number of 7,410,000 were taken. After being eyed these were sent to other stations on Hoods Canal to be hatched and the progeny were returned to the Dusewallops River in the advanced fry stage. While such transfers of eggs and fry involve some extra labor, they undoubtedly result in economy, as the expense of operating pumps and maintaining the Brinnon substation during the time required to incubate the eggs and develop the fry would exceed the cost of the transfers by a wide margin.

DUCKABUSH (WASH.) SUBSTATION.

There were distributed from this point during the year upward of 14,500,000 fry and fingerling fish, the species including chum salmon, silver salmon, and steelhead, and approximately 1,250,000 young fish were left in the ponds and troughs at its close.

In July and August a rack was installed in the Duckabush River near its mouth for the capture of spawning fish from the early run of chum salmon. Because of its low banks rack construction on this river is not an easy matter, and any barrier tending to impede the flow of the stream must be carefully watched to prevent damage from overflow on to adjacent agricultural lands. During the month of September 10,870,000 eggs were taken, and as this number, together with the eggs expected from the Brinnon collecting station, would fill all the hatchery space available, the collections

were discontinued though spawning fish were still plentiful. Eggs received from Brinnon numbered 5,501,000, and late in December 80,000 eggs of the late run of chum salmon were taken at the trap on the station grounds.

While the run of silver salmon in Duckabush River appeared from all observations to be greater than that of an average season, the number of eggs secured would seem to indicate the contrary. This is explained by the unfavorable water stages, which interfered with the work to such an extent that only 97 female fish were taken. This stock yielded 260,000 eggs. An additional lot of 780,000 eggs of this species, an overflow from the Birdsview station, was also incubated. During the spring months 255,000 steelhead eggs were obtained from fish entering the traps.

QUILCENE (WASH.) SUBSTATION.

The egg collections from fields in the vicinity of the Quilcene station during the year amounted to 9,475,000, the species including chum and silver salmon and the steelhead. In addition to this stock, eggs to the number of 4,107,290 were acquired by transfer from other fields, 1,657,290 of them being humpback-salmon eggs taken in Alaska waters by employees of the State of Washington. All eggs handled were successfully incubated, and the aggregate output totaled 11,451,200 advanced fry and fingerling fish divided as to species as follows: Chum salmon, 8,729,580; humpback salmon, 1,483,790; silver salmon, 752,275; steelhead, 545,555. In addition to the distributions made, 1,310,950 fingerling fish remained on hand at the close of the year.

SULTAN (WASH.) SUBSTATION.

As at the Birdsview station, low-water stages at spawning time seriously interfered with egg collections during the early fall. Thus only 79,000 chinook-salmon eggs could be obtained, these being taken between October 25 and November 4. As at Birdsview, also, the streams reached their normal level before the peak of the silver-salmon spawning season had passed, and under these improved conditions 4,065,000 eggs were taken, the collections being made between October 25 and January 13. This stock exceeded last year's collection by more than 1,700,000. Because of lack of hatchery space 650,000 of the eggs were sent to the Quilcene station for incubation. An average collection of steelhead eggs was made during the spring, the spawning season extending from April 8 to June 4.

QUINAULT (WASH.) STATION.

[Philo B. Hawley, Superintendent.]

In accordance with plans previously outlined for this station, sockeye-salmon propagation, the principal item of the fish-cultural work, was omitted during the fiscal year 1923 except for the distribution of 944,000 fingerlings of that species which had been carried over from the previous year. The distributions also included 78,000 steelhead fingerlings, the product of the preceding year's egg col-

lections, and 45,000 black-spotted-trout fry, the eggs of which had been transferred from the Yellowstone National Park. The only eggs collected for the station were 410,000 of the steelhead taken at the trap during May in connection with the salmon census. The progeny of these were still on hand at the close of the year.

The counting weir was installed and ready for operation by March 17, 1923. The first count was made three days later, and from then on to the end of June counting was a daily occurrence. The results of the work during this period, together with a record of the daily count for the corresponding portion of the preceding year, are indicated in the following table:

Daily count of sockeye salmon entering Quinault (Wash.) Lake during the fiscal year 1923, showing number of fish marked by gill nets each day.

Date.	1923		1922	
	Number of fish.		Number of fish.	
	Total counted.	Marked by gill nets.	Total counted.	Marked by gill nets.
Mar. 20	20			
21	34			
22	14			
23	14			
24	35			
25	7			
26	76			
27	23			
28	42			
29	65		65	
30	56		42	
31	42		185	
Apr. 1	91	5	200	
2	228	9	188	
3	55	3	349	
4	111	3	591	
5	132	5	860	
6	125	3	316	
7	75	1	194	
8	53	1	483	
9	120	2	197	
10	42	1	91	4
11	130	6	122	6
12	123	2	60	4
13	117	4	97	5
14	66	1	190	15
15	126	4	147	12
16	64	3	171	14
17	135	5	130	17
18	63	1	139	12
19	90	5	125	18
20	80	3	143	18
21	122	4	174	27
22	225	3	159	23
23	92		177	22
24	91	3	187	27
25	101	4	218	27
26	220	5	130	27
27	53	3	243	42
28	320	13	289	36
29	100	4	410	44
30	166	5	250	48
May 1	230	6	173	33
2	636	33	358	57
3	908	43	870	163
4	462	19	1,039	98
5	186	13	1,323	143
6	156	10	901	78
7	150	13	922	107
8	187	8	216	37
9	330	20	1,106	147
10	206	14	1,868	139
11	410	19	1,200	99
May 12	170	8	996	63
13	587	33	874	95
14	246	30	719	43
15	550	43	1,111	62
16	500	45	1,201	127
17	700	35	1,896	184
18	365	15	2,341	195
19	1,045	48	432	37
20	155	11	1,175	204
21	1,951	141	1,056	144
22	2,389	238	996	168
23	1,849	169	3,571	525
24	4,713	237	3,403	217
25	2,101	159	3,996	288
26	1,567	102	2,334	180
27	3,147	159	2,351	365
28	778	45	5,512	469
29	1,054	78	5,261	269
30	3,588	254	9,569	854
31	6,200	489	17,840	1,500
June 1	1,720	139	8,649	721
2	4,690	432	4,812	287
3	5,080	548	3,047	321
4	1,620	150	5,262	283
5	8,077	605	4,051	281
6	7,398	548	9,189	1,199
7	5,223	345	6,288	566
8	2,765	248	4,206	368
9	1,680	187	4,316	389
10	477	52	3,918	314
11	2,330	230	4,114	639
12	3,230	359	4,272	622
13	3,534	387	13,987	1,497
14	2,760	458	8,738	783
15	1,613	161	7,109	728
16	2,360	248	5,650	597
17	1,120	209	2,327	140
18	930	94	1,336	48
19	2,463	297	1,202	44
20	1,923	178	841	34
21	1,008	103	1,258	33
22	708	46	781	78
23	1,088	48	765	39
24	1,117	60	709	25
25	2,934	68	910	26
26	2,672	48	1,699	40
27	1,510	42	1,328	33
28	7,757	119	1,457	22
29	1,131	19	1,094	15
30	644	15	2,292	25
Total	123,022	9,088	199,489	17,735

Inasmuch as the run of sockeye salmon in Quinault Lake involves a part of two fiscal years, the total run for any one calendar year does not appear in the annual reports. Thus, during the calendar year 1922 fish were running and daily counts were made during the period from March 29 to September 13, 1922, inclusive, and during this time 49,466 salmon passed up the river. These, added to the count up to and including June 30, 1922, give a total of 248,932 fish entering the lake during the full period of the 1922 run. A table showing the daily count for this portion of the calendar year 1922 is herewith appended:

Daily count of sockeye salmon entering Quinault Lake, from July 1 to September 13, 1922.

Date.	Count.	Date.	Count.	Date.	Count.
July 1	1,886	July 27	818	Aug. 22	107
2	1,798	28	728	23	67
3	2,191	29	786	24	78
4	2,065	30	1,868	25	111
5	1,446	31	858	26	197
6	1,303	Aug. 1	1,502	27	473
7	1,015	2	1,542	28	496
8	1,228	3	750	29	254
9	779	4	682	30	120
10	1,092	5	774	31	135
11	738	6	458	Sept. 1	117
12	726	7	300	2	28
13	922	8	59	3	91
14	1,265	9	425	4	81
15	1,013	10	483	5	115
16	694	11	416	6	111
17	858	12	732	7	248
18	691	13	100	8	53
19	1,546	14	66	9	28
20	894	15	455	10	53
21	1,196	16	249	11	40
22	2,263	17	75	12	7
23	1,459	18	136	13	92
24	540	19	236		
25	1,065	20	158	Total	49,446
26	839	21	176		

An estimate of the probable number of fish that will enter the lake during the full term of the 1923 run, based on a comparison with last year's figures, would place the total for the calendar year 1923 at approximately 150,000, or about 61 per cent of the large run of the preceding year.

In the census for both the years referred to fully 7 per cent of the fish counted had been marked by the gill nets in use in the commercial fishery near the mouth of the river. Probably not less than 50 per cent of the fish marked were so badly scarred and lacerated that death before spawning time seemed inevitable. This means that one-half of the 9,091 net-marked fish passing through the weir between March 20 and June 30, 1923, constituted a total loss not only to the trade but to the work of propagation. Figuring at the current prices for marketable fish, this represents a monetary loss to the Indian fishermen of about $2,700.

The escapement for the calendar year 1922—very nearly 250,000—was probably as large as could reasonably be expected, and though comparatively little is known on the subject this number would seem to insure an ample return at the completion of the life cycle

for the maintenance of the species in Quinault Lake, provided the fish find congenial spawning areas and the eggs and resulting progeny are not subjected to untoward conditions. The returns from the natural spawning of these years will be of interest to all observers.

During the spawning season of 1922 conditions were apparently not conducive to the best results from natural spawning. The customary fall rains were much restricted, and neither Quinault Lake nor its tributaries attained the normal high fall levels. At no time in the course of the spawning period did the lake rise to more than 3 feet above the average summer stage. As a result the spawning sockeyes were not induced to ascend to the upper reaches of the larger tributaries. Large numbers resorted instead to the smaller streams entering the lake, greatly congesting these limited spawning areas, while the more extensive grounds in the larger streams received only a comparatively few eggs. Never before in the history of the station has such a large number of spawning sockeyes entered Falls Creek, the small tributary on which the hatchery is located. It was estimated that not less than 10,000,000 eggs could easily have been taken from this stream alone.

Reports having reached the station during December that sockeyes in considerable numbers were returning to the ocean, an investigation was instituted, which indicated that Indians fishing near the mouth of the river for silver salmon and steelheads were taking from 30 to 40 sockeyes daily. All that were examined were typical spawners in a much emaciated condition. It was assumed that because of the low-water stages they had remained in Quinault River throughout the spawning season without entering the lake.

During November a five-day trip was made along the upper Quinault River and its tributaries for the purpose of ascertaining the number of fish that had resorted to those waters, the condition of the spawning beds, and other relevant information. Some 12 miles above Quinault Lake the so-called East Fork and the North Fork unite to form the upper Quinault River. The East Fork contains many small sloughs and shallow gravelly stretches, comprising very fair spawning beds. Sockeyes were noted working on these beds as far up as the junction of the Big South Fork with the East Fork, about 18 miles above the lake. At some distance above this point the river contains a succession of rapids and it is doubtful if spawning fish are able to surmount them.

The North Fork appears to be quite lacking in suitable spawning grounds, and no fish were seen in it beyond a distance of 2 miles above its junction with East Fork, though the examination was continued for a distance of more than 8 miles above that point.

It was estimated that perhaps 25 per cent of the fish reaching Quinault Lake resorted to the upper Quinault for spawning, and that not less than 75 per cent of this number remained in waters below the forks. During the progress of the investigation Big Creek, Merriman Creek, and Inner Creek, all tributaries of the upper Quinault River below the forks and from which egg collections are customarily made, contained large numbers of salmon.

Of special interest in connection with the natural reproduction of salmon in the upper Quinault River are the changing conditions brought about by the destruction of the forests. Local residents

describe this river and its principal tributaries of 20 years ago as streams of moderate breadth flanked by heavy timber growth. At the present time this territory is subjected to ever-recurring floods, and the devastated area resulting from the shifting of channels varies in width from one-fourth to one-half a mile, and is noticeable throughout the entire distance of 12 miles to the main forks.

CLACKAMAS (OREG.) STATION AND SUBSTATIONS.

[HUGH C. MITCHELL, Superintendent.]

The "pack" of canned salmon from the Columbia River during the calendar year 1922 was one of the lightest in the history of the industry, and the supply of salmon eggs for artificial propagation fell off proportionately at all of the Columbia River hatcheries, both Federal and State, with the single exception of the State hatchery at Kalama, Wash. On the other hand, the number of salmon reaching the spawning areas in the vicinity of the bureau's stations was much larger than might have been expected in view of prevailing conditions.

The intensive fishing to which the Columbia River was subjected during the years 1915 to 1920, inclusive, and the comparatively large numbers of fish taken commercially in those years may have been factors in reducing the runs of the past two seasons. However that may be, there was a marked improvement in the commercial catch of chinook salmon at the beginning of the 1923 fishing season, and the greater measure of protection afforded immature fish in the ocean and river by the recent removal of purse seines therefrom may be expected to ultimately benefit the fishery.

With the Clackamas station as headquarters, fish-cultural operations were conducted during the fiscal year 1923 at 12 widely separated points in Washington, Oregon, and Idaho. Seven of these field stations are permanent, being in active operation throughout the year, while the others are merely eying stations or egg-collecting auxiliaries.

The aggregate egg collections of the group amounted to 35,371,000, as against 63,658,000 the previous year. Of this number 26 755,000 were chinook salmon; the remainder comprised such species as silver, chum, sockeye, and steelhead salmon, and the black-spotted trout. Besides the eggs collected in the various fields, 5,000,000 chinook-salmon eggs were transferred from the State hatchery at Kalama, Wash., and smaller consignments of brook, rainbow, and lake-trout eggs were received at Clackamas from other stations of the bureau.

The combined output of the Oregon group of stations in eggs, fry, and fingerling fish amounted to 30,540,800, this number including the fingerling fish carried over from the previous year. The output included three shipments of fish eggs to foreign governments, one of 200,000 chinook-salmon eggs being sent to the Netherlands and two of steelhead eggs going to Germany and Argentina. At the close of the year approximately 1,500,000 eggs, fry, and fingerling fish were still on hand.

The use of immature salmon eggs as food for fry and fingerling fish was continued throughout the year on an extensive scale, the station superintendent having found from past experience that this

material, when properly cooked and mixed with beef spleen, makes a highly desirable food for young salmon. As its cost in the Oregon field is very low, arrangements have been made to hold in cold storage upward of 10 tons from the 1923 pack of salmon for the coming year's food supply. The superintendent has also found, after two seasons' trial, that feeding young fish only twice a day produces equally as good results in growth and vigor as are attained by the customary method of administering food more frequently. Aside from large quantities of immature salmon eggs, the principal food materials during the year consisted of salted salmon, canned salmon, and beef spleen.

CLACKAMAS (OREG.) STATION.

Seven species of salmonoid fishes are represented in the fish-cultural work of the year at this station—chinook, silver, chum, and steelhead salmon, brook, black-spotted, and lake trout. Egg collections from the Clackamas River were made between September 23 and November 17, 2,750,500 of the chinook salmon being taken, together with incidental collections of chum and silver salmon, the numbers amounting to 18,500 and 10,700, respectively. Transfers from other points included 220,000 brook-trout eggs from Utah, about 75,000 black-spotted-trout eggs from the Yellowstone National Park, 25,000 lake-trout eggs from Minnesota, 45,000 steelhead eggs from the Sandy River auxiliary, and 1,750,000 chinook eggs from the Little White Salmon substation. A high percentage of fry was produced from all eggs handled except those from Utah. On these a rather heavy mortality was experienced and the fry and fingerling fish resulting from them were below the average in vigor.

UPPER CLACKAMAS (OREG.) SUBSTATION.

In addition to the usual retaining rack constructed in the river just below the milldam, a second rack and a downstream trap were installed at Brions Eddy. Though there was a light run of fish and illegal fishing was prevalent, 857,000 salmon eggs were secured by means of this equipment, and from them a fair percentage of fry was hatched and successfully carried to the feeding stage. On the night of January 6, when the Clackamas River reached the highest stage ever recorded in this region, the hatchery site was practically washed away and the small remaining area covered with logs and débris. The station buildings suffered some damage and it became necessary to abandon the work pending the selection of a new hatchery site. The fish on hand at the time of the flood were all released in the river in good condition.

LITTLE WHITE SALMON (WASH.) SUBSTATION.

Considerable work in the line of improvements and repairs to station property was accomplished during the year at this point, the most important being the construction of a new hatchery on the site occupied by the two old buildings that have served in that capacity for a long term of years. Repairs of a rather extensive nature were also made on the water-supply flume, which had been damaged by

snowslides during the past winter, when a serious loss of stock was narrowly averted. The floods occurring throughout the Columbia River Basin in January, 1923, caused some further damage to this flume and other property. The new hatchery is a frame structure, 40 by 140 feet in dimensions, on a cement foundation. It is equipped with 128 hatching troughs, providing holding capacity for upward of 30,000,000 salmon eggs during the incubation period.

In the fall of 1922 the usual fishing operations were conducted, and 14,261,000 eggs were taken between September 22 and October 14, practically all of them being chinook-salmon eggs, though small numbers of chum and sockeye eggs were also acquired. In addition to these collections 5,000,000 surplus chinook-salmon eggs from the Washington State hatchery at Kalama were handled. Excellent results attended the incubation and rearing operations, and the year's output amounted to 16,743,900 eggs and young fish. Of this number 12,427,000 were fingerlings from 1½ to 3 inches in length. Shipments of eyed eggs were made from the Little White Salmon hatchery to central station, Washington, D. C., to the State of Oregon, the University of Washington at Seattle, Wash., to the Netherlands Government, and to other stations of the local group.

BIG WHITE SALMON (WASH.) SUBSTATION.

A considerable amount of work in the line of improvement to property was also accomplished at this point. The hatchery building was moved to a more favorable site, remodeled, and thoroughly repaired. As reconstructed it consists of a frame building, 40 by 100 feet, on a cement foundation. It is equipped with 83 standard hatching troughs, having a capacity for approximately 20,000,000 salmon eggs.

During the spawning season, extending from September 22 to October 10, 6,237,000 chinook-salmon eggs were obtained from local spawning areas. Five hundred thousand eggs of the silver trout and 235,000 of the brook trout were incubated during the year for the Washington fisheries authorities, and the resulting fry turned back to the State officers for distribution. The total output of young salmon amounted to 6,000,000 fingerlings, ranging from 2 to 3 inches in length.

ROGUE RIVER (OREG.) SUBSTATION.

The usual difficulties were encountered in attempting to hold fishing appliances in the Rogue River during the freshets resulting from melting snow in the upper reaches, and conditions would not permit of really profitable work in egg collecting until August 9. From that time until the racks were destroyed by spring floods in the following May fishing operations were diligently prosecuted. The egg collections, including a small number taken in Elk Creek below the dam were:

	Number of eggs.
Chinook salmon	1,235,000
Steelhead	354,700
Black-spotted trout	33,900
Silver salmon	20,500
Total	1,644,000

APPLEGATE CREEK (OREG.) SUBSTATION.

Fish-cultural operations at this point involved the silver salmon and the steelhead. The spawning season of the former extended from November 28 to January 16, while eggs were taken from the other species between January 16 and May 16, the collections amounting to 2,458,000 and 3,266,000, respectively. The changes made in the fishing racks during the past season proved highly satisfactory, and this improvement, together with the favorable climatic conditions prevailing throughout the season, made it possible to secure a very fair collection of eggs.

The usual transfers of eyed eggs were made, including steelhead eggs, to the Rogue River station, the Oregon State hatchery at Butte Falls, Oreg., and to eastern applicants. The retained eggs produced a remarkably high percentage of fry, all of which were successfully reared to fingerlings No. 1½ and No. 2 before releasing in local streams. About 600,000 fingerling steelheads remained on hand at the end of the year.

SANDY RIVER (OREG.) SUBSTATION.

The previous year's fish-cultural operations at the Sandy River site having proved eminently successful, it was deemed advisable to establish a permanent substation at that point. With this end in view a hatchery building, 29 by 58 feet, of frame construction on a cement foundation, a water supply line, and a four-room cottage were constructed and made ready for the work in advance of the spawning season.

The numbers of chinook and silver salmon reaching the racks were small as compared with last year's run, the decline being attributed to the diversion of a considerable portion of the river water supply to the operation of a hydroelectric plant in the vicinity. Notwithstanding this handicap, chinook-salmon eggs to the number of 461,900 were secured, the spawning season extending from August 22 to December 7. Water conditions in the river were improved during the spring months, and between March 31 and the end of the first week in June 832,600 steelhead and 330,600 silver-salmon eggs were collected.

The Sandy River substation is located near the base of Mount Hood, and the winters are sometimes so severe that slush ice occurs in the river. Taking this fact into consideration, provision has been made for the construction of a flume to conduct water from the river and also for an auxiliary flume between the hatchery and Spring Creek. By this means the possible failure of the water supply during periods of intense cold is guarded against.

Under normal conditions there is a good run of the highly prized chinook salmon, and also of the steelhead in Sandy River, and the site gives promise of fruitful results at a low cost for maintenance.

WASHOUGAL RIVER (WASH.) SUBSTATION.

This eying station was in operation during the spawning season of the steelhead, from April 13 to May 23, during which period 834,000 eggs were taken. A heavy run of fish passed up the river;

but, as in previous seasons, large numbers of them were not sexually mature. All immature fish taken were carried above the dam and released.

SALMON (IDAHO) SUBSTATION.

With the recently constructed buildings near Salmon, Idaho, as headquarters, temporary egg-collecting stations were established in this field on the Lemhi, Pahsimeroi, and Yankee Fork Creeks, and at Sunbeam Dam. The run of salmon was light at all points, but especially so at Yankee Fork, and the work there was abandoned early in the season, it being apparent that eggs could not be obtained in numbers sufficient to warrant the expense of maintaining racks.

After being developed to the eyed stage, the eggs collected from the various streams in this region were transferred to the hatchery at Salmon for incubation. The year's distributions from this substation included 1,124,700 chinook salmon, 236,000 rainbow trout, and 99,000 brook trout, all fingerlings. The output of the two species of trout was the result of transfers of eggs made from other stations.

A further examination of the Salmon River district was made during the year, and from the evidence obtained on this and previous trips it appears certain that at least a majority of the sockeyes in the Columbia River originates in lakes in the Sawtooth Mountains. The species was first observed in the Salmon River, near Bay Horse Canon, in August, and at Sunbeam Dam some 10 days later. It was further noted that salmon entered most of the tributaries of the three rivers inspected. It is not probable that fish enter all these streams in large numbers, but at the time of the inspection each stream appeared to have a run.

BAIRD (CALIF.) STATION AND SUBSTATION.

[W. K. Hancock, Superintendent.]

The results of the year's fish-cultural work at all points in the California field were discouraging in the extreme, the egg collections and the output of young fish being the smallest since the inception of the bureau's fish-cultural operations in the State.

While extremely low water stages prevailed everywhere in this region during the spawning season, hampering the run of fish, and other climatic conditions were not altogether favorable, the very unusual scarcity of fish on their wonted spawning areas can hardly be attributed to natural causes alone. The principal reasons for the decline must, for the present at least, be the subject of conjecture. Among the theories advanced have been (1) excessive fishing by purse seines in the lower Sacramento River and (2) loss of fish through their entrance into the numerous irrigating ditches recently constructed.

Peculiarities noted in connection with the season's work at both the substations in the California field were the large size of the few spawning females taken and the excessive numbers of undersized and immature males present. However, at the Baird station, on the McCloud River, the mature females exceeded the males in number.

BAIRD (CALIF.) STATION.

During the month of April, 1922, racks were installed in the McCloud River with the object of securing for incubation eggs of the spring run of chinook salmon. Throughout the spring and summer there seemed to be no well-defined run of salmon, but a few fish reached the barrier every day during the season. Spawn-taking operations extended from September 8 to September 29, by which time 1,521,000 eggs of good quality had been laid down in the hatching troughs. This number compares favorably with the work of the past few years.

Because of the depth of water and the uneven nature of the bottom of the pool in which the fish were held pending the development of their eggs, it was not an easy matter to capture them for spawn taking. They refused to enter the traps, and gill nets were ineffective. Seining after dark proved to be the best method, though a considerable number evaded any method of capture that could be devised, and these were finally permitted to pass the racks to spawning sites of their own selection.

Even for that arid section of the State the season was an unusually dry one, and water for the hatchery through the gravity supply ditch was not available. To avoid the expense of pumping water from the river an improvised battery of troughs was set up on the grounds and supplied with water from a small spring. By careful management this small amount sufficed until the eggs had about completed hatching, by which time it became necessary to move the stock into the hatchery and start the pumps. From October 6 until the last of the fish had been distributed, in March, the pumps were kept in continuous operation, the necessary amount of water not being available from any other source.

At the close of the spawning season of the spring run of salmon the racks were removed from the river, as appearances did not indicate that the fall run would be of sufficient importance to warrant the cost of egg collections. Furthermore, after the customary fall rains set in it is only with the greatest difficulty that racks can be maintained in the McCloud River, and should the expected rains fail, as proved to be the case, the available water supply is sufficient only for the eggs already on hand. The racks were again installed during April, 1923, for the interception of the spring run of the succeeding season.

A close watch was kept on the dam in the Sacramento River near Redding, to note the effectiveness of the openings in the "splash boards" in permitting the passage of fish. The station superintendent has expressed the opinion that these openings probably serve their purpose as adequately as could the conventional fishway. He states that such fish as find the openings pass readily over the dam, but that a large number fail entirely to find them, and are thus prevented from reaching suitable spawning places.

During the year reports reached the superintendent to the effect that adult salmon in numbers were entering the irrigation ditches. Such reports could not be substantiated, however, and the several visits made to the points complained of indicated that the screens were intact and properly installed.

BATTLE CREEK (CALIF.) SUBSTATION.

As at the Baird station, the season at this point was marked by scarcity of rainfall, with low-water stages in all the surrounding streams. The fishing racks were installed as usual, but active fishing operations, conducted from October 19 to November 28, resulted unsatisfactorily. Seining on the riffles in the Sacramento River below the mouth of Battle Creek proved equally unremunerative, and when the attempt was finally abandoned there were 1,587,000 eggs in the hatchery.

As previously mentioned, the season's run of fish was unique, both on account of its small size and because of the nature of the fish comprising it. The few sexually matured females taken were unusually large, yielding an average of 6,000 eggs per fish. However, the majority of the run was composed of immature males.

In past years attempts have been made to procure eggs of the spring run chinook salmon at various points on Battle Creek, but the attempts have never met with success. The early run appears in the stream in the spring or early summer, but the fish are not in spawning condition until late August or early September. The great difficulty thus far encountered in this field has been to find a suitable place with a sufficiently low water temperature for holding the fish through the hot summer months pending the maturity of their eggs.

It has been ascertained that the water temperature below the dam of the Coleman Power Co. plant, some 4 miles from the Battle Creek hatchery, averages from 5° to 6° lower throughout the entire summer than at any of the other points investigated. Because of this favorable condition it seems probable that successful work may be accomplished below the dam, and with the view of determining this point racks were installed late in May for holding a limited number of fish for observation.

MILL CREEK (CALIF.) SUBSTATION.

The total take of chinook-salmon eggs at this point amounted to 791,000, being the smallest secured since fish-cultural work was first inaugurated there. The reasons ascribed for the failure of the fish to appear have been mentioned, but they are far from satisfactory. The drought conditions extended to this station, but in August, when the racks were installed, the creek was entirely dry, all of the natural flow having been diverted for irrigation purposes. Spawn taking began October 29 and was continued to December 27. As at Battle Creek, practically the entire run of fish appearing at the racks in Mill Creek was composed of immature males.

GREAT LAKES FISHES.

The territory covered by the work in the propagation of the commercial fishes coming under this head extends from Lake Superior on the west to Lake Champlain on the east, and, with the possible exception of salmon propagation, it is the most important branch of the bureau's fish-cultural activities. The commercially valuable fishes of the Great Lakes are the lake trout, whitefish,

cisco, and pike perch. In addition to these, carp and yellow perch have become commercially prominent and large numbers of their eggs are hatched annually and the product returned as fry to parent waters. The total egg collections of this group of stations in 1923 was approximately 1,082,000,000, showing a decrease of about 467,000,000 as compared with this branch of the work last year. The largest part of this decrease occurred in the cisco and pike perch, and the principal causes for it may be attributed to unseasonably cold weather during the spawning period and lack of sufficient funds for prosecuting the work to its fullest extent in some of the fields occupied. Owing to the latter circumstance the pike-perch hatchery at Swanton, Vt., was not operated.

DULUTH (MINN.) STATION.

[S. P. WIRES, Superintendent.]

Collections of eggs of the lake trout for stocking the Duluth hatchery were made at the usual field stations in Lake Superior during the fall, the spawning period extending from September 25 to November 15. Eggs to the number of 16,132,000 were secured, and on November 25 this stock was increased by the receipt of 6,000,000 green eggs from the Charlevoix (Mich.) field. The eggs from Lake Superior were of good quality, but for some reason the transferred eggs were exceptionally poor. Eyed eggs to the number of 525,000 were furnished to applicants, and 250,000 were forwarded to other stations of the bureau; the remainder were hatched and the product returned to the spawning grounds in Lake Superior, the distributions aggregating 13,170,000 fry and 85,000 No. 1 fingerling fish.

The whitefish eggs handled during the year—5,060,000—were collected in connection with the lake-trout work at Isle Royale, Mich. Notwithstanding the fact that they were secured under rather unfavorable conditions, 2,770,000 fry of excellent quality were hatched from them and returned as fry to the native spawning grounds.

As a result of cooperative work between the station and the Minnesota Fish Commission in the collection of pike-perch eggs in the Rat Root River region of Minnesota, the station received as its share of the proceeds 25,000,000 eggs, 5,000,000 of which were eyed. The green eggs, received May 5, appeared to be in good condition on delivery, but within 48 hours after installation in jars it was discovered that the loss would be heavy as not more than 15 per cent were fertilized. From the entire stock 7,630,000 fry of good quality were hatched and distributed, going to applicants in Minnesota, Wisconsin, and Michigan.

The brook trout listed in the distributions from the Duluth station resulted from 147,000 eyed eggs acquired by purchase from a commercial breeder, while the rainbow trout were carried over from the hatch of the preceding year. A consignment of 100,000 steelhead eggs, received from one of the bureau's substations in Oregon on May 24, yielded a total of 90,000 fry and fingerling fish.

Of passing interest in connection with the incubation of the lake-trout eggs was the unusually large percentage of albinos resulting from a lot of eggs obtained at Isle Royale, Mich. These eggs—about

100,000 in number—arrived at the station early in October, and approximately 5 per cent of the 70,000 fry hatched from them were albinos.. So far as could be learned there was nothing unusual in the appearance of the parent fish. The albinos were reared with the colored fish without undue loss.

NORTHVILLE (MICH.) STATION AND SUBSTATIONS.

[W. W. Thayer, Superintendent.]

NORTHVILLE (MICH.) STATION.

Distributions of smallmouth black-bass fingerlings Nos. 2 and 3 to the number of 14,475 were made during the first month of the fiscal year, and in October the brood stock of this species was increased to a total of 500 by the addition of 100 adult fish derived from collections in Lake Erie. In the spring, when the water in the ponds containing these fish was drawn down, only about 300 could be found. It is impossible to account for the shortage, as no such loss of brood stock has ever occurred heretofore. The available adults were installed in spawning ponds on May 3 and began nesting a few days afterwards. On the evening of May 8 a heavy snowstorm of 24 hours duration set in, causing a drop in water temperature from 65° to 41° and destroying all nests of eggs in the ponds at the time. As soon as the temperature returned to normal spawning was resumed, and in the course of the season 75 nests of eggs were deposited. At the close of the year 48,500 bass fry and fingerlings No. 1 had been gathered from these ponds and distributed, and it was estimated that about 50,000 were still available.

To relieve the conditions existing at the Alpena substation in connection with an unsuitable water supply, part of the green lake-trout eggs at that point were transferred to Northville and carried until they were near the hatching stage, when they were returned to Alpena.

During the winter 345,120 eyed brook-trout eggs were received from a commercial dealer in Massachusetts. These were of fine quality and produced a good percentage of healthy fry. All but 28,000 of these fish had been disposed of before the end of the year. The station also handled 126,000 eyed rainbow-trout eggs furnished by the Michigan fisheries authorities. The fry produced from these were still on hand at the close of June.

A brood stock of adult bluegill sunfish, collected from a lake near Vicksburg, Mich., was installed in a spawning pond early in May. A few nests were observed in this pond during the spring, but the results of the experiment can not be determined until the water is lowered in the fall.

CHARLEVOIX (MICH.) SUBSTATION.

In arranging for the collection of lake-trout eggs for filling the Charlevoix hatchery the procedure of past years was followed so far as was possible, experienced men being stationed at the best fishing ports on Lakes Michigan and Huron to instruct local fishermen as to the proper manner of taking spawn and caring for it during the early stages. However, a sufficient number of men experienced in

the work could not be found to cover all fields and at some points local help had to be employed to perform this important duty. Under such circumstances it was impossible to secure a uniformly good grade of eggs, and while the season's collections—amounting to 55,640,000—were considerably in excess of the total of any year in the recent past, their quality was far below the desired standard. The collecting season extended from October 31 to December 22, and the incubation of the eggs was completed at the expiration of 140 days in a mean water temperature of 38.5°.

The salt-solution process was employed almost throughout the season for separating poor eggs from the good ones, thereby effecting a large saving in the employment of temporary help. In connection with the work it was discovered that good eggs were being carried out of the troughs with the discarded ones, and a method was at once devised and put in operation by the assistant in charge of fish culture, which conserved practically all good eggs.

Collections of whitefish spawn were made at various points in Lake Michigan between November 16 and December 30, the season's total aggregating 16,660,000. This stock was augmented in December by the receipt of the partially incubated eggs from the Alpena hatchery, though most of the transferred eggs were returned to that point just prior to the hatching stage. The incubation of the eggs was completed at the end of 180 days in a mean water temperature of 39°. In order to effect any considerable improvement in whitefish propagation in this region it will be necessary to provide penning facilities at suitably located points for the holding of the partially ripened fish until their eggs are fully matured. Some investigations are now being made with the view of establishing several of such stations as soon as funds are available for the purpose.

Early in April 15,827 eyed eggs of the landlocked salmon were received from the bureau's Craig Brook (Me.) station. They were hatched with not more than normal losses and carried in good condition until about the time when the sac was absorbed, at which period the water supply became polluted from the exhaust of the city water-works engine and one-third of the stock was lost. The remainder was delivered to an applicant for that species.

ALPENA (MICH.) SUBSTATION.

While whitefish and lake-trout eggs are collected annually in the Alpena field, for several years past no attempt was made to incubate them in the Alpena hatchery, as the city water supply, upon which the substation is dependent, was so heavily charged with chlorine as to be very injurious to eggs or fry held in it. Having received information that the conditions in this respect had improved somewhat, the hatchery was stocked by the bureau during the fall of 1922 with whitefish and lake-trout eggs secured in the immediate region. It quickly developed, however, that the water supply was still detrimental, and all stock on hand had to be transferred, being divided between the hatcheries at Charlevoix and Northville. Acting on advice from the city authorities that the contemplated operation of a filtration plant in course of construction would obviate the necessity of chlorinating the water after March 1, 1923, the eggs sent to other points earlier in the season were returned to Alpena

just prior to the hatching stage with the view of effecting some economy in the distribution of the product. Owing to a delay in starting the plant the use of the chlorine was not discontinued, and to avoid the threatened loss of the entire stock all eggs and fry in the hatchery were liberated on March 23 on the local spawning grounds, after which the hatchery was closed.

PUT IN BAY (OHIO) STATION.

[S. W. DOWNING, Superintendent.]

The season's arrangement for the collection of whitefish eggs in the Lake Erie fields having been completed by early November, it was deemed advisable to place men in the collecting areas around Toledo and Port Clinton in advance of actual spawn-collecting operations to give instructions to the various fishermen as to the proper manner of taking the eggs and caring for them until they could be turned over to the bureau's agents. Between November 14, when the first eggs were taken, and the close of the season on December 4 the collections amounted to 242,720,000, approximately 143,000,000 less than were secured last year. Of this number 104,000,000 were obtained in the Port Clinton field; North Bass Island, the field of next importance, yielded 75,000,000; 17,720,000 were taken in the vicinity of Middle Bass Island; while collections only a little in excess of 15,000,000 for each field were secured in the neighborhood of Toledo and Catawba Island. Slightly more than 11,000,000 were taken in the vicinity of Put in Bay, while at Pelee Island, Canada, 3,440,000 were secured.

The comparatively poor results of the work are attributable to the natural conditions existing during the spawning season. The water seemed to contain a great quantity of slime, and the spawning fish and the eggs had a decidedly soft, slimy feeling. The eggs failed to harden properly even under the most careful treatment. Information was received to the effect that the same conditions were met with throughout the Great Lakes region, but the situation is believed to have been intensified in the Lake Erie fields, both by the unusually high water temperatures prevailing and by the steady westerly winds, the latter resulting in such low water stages at the western end of the lake that the sediment and slime at the bottom were washed up and mingled with the general supply. Late in the spawning season, after the winds had subsided, the water cleared and there was a noticeable improvement in the quality of the eggs taken during that period.

Of the eggs collected, 28,000,000 were shipped direct from the field to the Erie hatchery of the Pennsylvania Fish Commission, and 22,400,000 fertilized eggs were planted on reefs near the Put in Bay hatchery; 3,000,000 eyed eggs were forwarded to applicants and other hatcheries of the bureau, and from the remaining stock 100,000,000 fry were hatched and liberated on the spawning grounds. On account of the poor quality of the eggs as a whole, the percentage of hatch was about the lowest ever recorded at the station.

Early in the spring all prospects for a good collection of pike-perch eggs appeared favorable. The ice disappeared from the western end of the lake early in March, and for the first time in several

years the fishermen were able to set their nets at the beginning of the open season. The weather turned cold a few days afterwards, however, and the anchor ice formed by the heavy winds and snow became attached to the nets in large quantities, causing them to float, and some of them drifted away with the current to such a distance that they were never recovered. The spawning season extended from April 19 to May 6, and the storms prevailing throughout this period injured the nets so badly that the time of the fishermen was largely employed in making repairs, to the detriment of egg collections. Of the season's total—aggregating 192,440,000—eggs to the number of 37,275,000 were delivered in the green state to the Ohio Fish Commission, and 4,500,000 eyed eggs were shipped on assignment. The fry resulting from the remainder—amounting to 51,800,000—were liberated in the vicinity of the collecting fields in Lake Erie.

In connection with the pike-perch work, 900,000 eggs of the sauger (*Stizostedion canadense*) were obtained from fish taken in a trap net. These were incubated in the hatching jars without any difficulty and almost without loss, yielding over 90 per cent of healthy fry. The eggs are heavy, slightly adhesive, and measure 17 to the linear inch after being fully water hardened. All previous experience with sauger eggs at this station has been with spawn from fish taken in gill nets, and though the eggs have invariably been handled with the utmost care, in no instance have any fry ever been hatched from them. This would seem to indicate that the manner of capturing the fish has much to do with the quality of the eggs. The season's collections also included 3,440,000 yellow-perch eggs, from which 3,000,000 fry were hatched and planted.

Very successful results were obtained in the propagation of carp. Eggs of this species were taken between June 1 and June 20 and a total of 160,500,000 was secured, this record exceeding that of any previous year since the inauguration of the work in 1918. The field of collection was extended to Sandusky Bay, where spawning fish were found to be very plentiful, and by this means a far greater number of eggs was secured than would have been possible from the Portage River alone. All eggs taken were of excellent quality and yielded a good percentage of fry. In making the distributions the fry were liberated over a distance of 12 miles in the Portage River, from Port Clinton to Oak Harbor.

A very unusual difficulty was encountered about the middle of December. Minnows in immense numbers, moving along the shores of the lake, were taken up in the water supply suction and carried against the screens of the tanks, which became so clogged with them as to be of no practical use. A few strokes of the pump would result in complete obstruction, and for three nights the entire station force was occupied in keeping the spigots free of minnows.

During the year the station steamer was placed in dry dock, all barnacles and rust removed, and the bottom painted with two coats of tar thinned with turpentine and applied with a common paint brush. This material has been used for several years for this purpose and has been found to be entirely satisfactory.

CAPE VINCENT (N. Y.) STATION.

[J. P. SNYDER, Superintendent.]

The repair work in progress at this station at the opening of the fiscal year was completed during the summer. Among the more important items accomplished were the following: Construction and installation in the fry building of two plank metal-lined tanks 17 feet long, 36 inches wide, and 30 inches high; removal of a defective hardwood supporting timber in the basement of the hatchery and replacing it with a new one; placing metal plates along the water line forward to protect the planking of the launch *Curlew*, and installing an electric-lighting plant on this launch. There being an excess of exhaust steam above the amount required for heating the hatchery, an underground exhaust-steam line was run to the residence and connected with the heating plant. The return pipes were carried back to the hatchery, where provision was made to use the hot condensed water in the boiler again.

A new 28-foot pound-net boat was purchased in advance of the fish-cultural season. This boat has a 9-foot beam and is equipped with a 14-horsepower, 2-cylinder, 4-cycle Regal motor. The shaft is fitted with a universal joint to permit the lifting of the wheel when running through shallow water.

The season's fish-cultural operations began on October 17 with the taking of the first lake-trout eggs in the Pigeon Island, Canada, field. The collections extended to November 12, and as they were conducted under favorable weather conditions more eggs than usual were secured, the total amounting to 1,281,000. Of these, 60,000 were shipped in the eyed stage, and the losses on the remainder to the time the resulting fry were distributed amounted to 11 per cent of the eggs retained for hatching. Very poor results were attained from a consignment of 4,880,000 green lake-trout eggs received in November from the Charlevoix (Mich.) substation. Nearly half of them were dead on arrival, and the losses continued heavy up to the middle of January. The output from this shipment amounted to 480,000 eyed eggs and 595,440 fry.

Permission having been obtained for the collection of whitefish spawn from nets operating along the Canadian shore of Lake Ontario, work was undertaken on the 1st of November at Bygotts Point and Deseronto, in the Bay of Quinte, and at a later period in the South Bay field. No eggs having heretofore been available on these grounds prior to November 3, it was assumed that the landing of the spawning crew on November 1 would be sufficiently early, but on the arrival of the men it was learned that the fish had been spawning for several days and that considerable numbers of eggs had been lost. No explanation can be offered to account for this spawning, as the season began later than usual in the field near South Bay, Ontario, and also in Chaumont Bay, in the New York waters of the lake. Notwithstanding these losses of eggs the jars in the Cape Vincent hatchery were filled to capacity before the season closed, and 77,009,000 additional eggs were furnished to the Canadian and New York fisheries authorities. The total collection for the season aggregated 228,650,000, of which 214,000,000 were obtained in the Canadian fields, and 14,650,000 in Chaumont Bay.

In the incubation of these eggs considerable difficulty was experienced from the presence of a parasitic or fungoid growth, which interfered with the proper separation of the dead from the living eggs. As the season advanced the eggs became so coated with this hairlike formation that they would not lie together closely in a uniform mass but were more or less suspended in the water current. To overcome this tendency the jars were taken down and the eggs screened and washed. This improved matters for a short time, but within a few days the treatment had to be repeated. This constant screening and washing, which had to be resorted to throughout the incubation period, not only involved much additional labor but it is believed also to have increased the percentage of mortality.

Cisco eggs to the number of 76,800,000 were collected between November 22 and December 9 in Fairhaven, Sodus, and Chaumont Bays, in New York waters, the first-named bay furnishing the bulk of the collections. Although the catch of cisco by commercial fishermen during the summer and early fall was above the average, for some unexplained reason the take during the spawning season was far below normal and egg collections were correspondingly reduced. On the development of the eggs to the eyed stage a shipment of 10,000,000 was furnished to the Michigan Department of Fisheries, and from the remainder 39,000,000 fry were hatched and distributed on the spawning grounds in Lake Ontario. Part of the losses on these eggs was due to the fungoid growth referred to in connection with the whitefish work.

During the winter the station received 553,000 brook-trout eggs from commercial hatcheries and distributed the product in the fry stage. A very satisfactory percentage of hatch was attained and the resulting fry did well up to the early part of April, when a weakness developed. Grouped together the young fish presented a whitish cast, and under the magnifying glass patches of mold or fungus became apparent. All except the more badly affected ones were restored to normal condition by applying a salt bath and then placing them in a village water supply.

In the course of the year the station received and hatched 100,000 eyed rainbow-trout eggs received from the Michigan Department of Fisheries, and 1,500,000 pike-perch eggs transferred from the Put in Bay (Ohio) hatchery. Under permit from the New York Conservation Commission several hundred brood yellow perch were captured in the St. Lawrence River and from them 1,000,000 eggs were collected, the adult fish being returned to the river at the end of the spawning season. The eggs were incubated in sunken wire baskets and the resulting fry were returned to the local spawning grounds.

BRYANS POINT (MD.) SUBSTATION.

[L. G. HARRON, Superintendent.]

Between the 4th and the 18th of March a total of 17,999 brood yellow perch was collected and installed in live cars near the Bryans Point station to serve as a source of egg supply for the hatchery. The fish spawned daily from March 18 to March 30, yielding 146,560,000 eggs, of which 9,165,000 were shipped, one consignment of 7,800,000 going to the Neosho (Mo.) station and the remainder being

divided between the Wytheville (Va.) and Erwin (Tenn.) stations. From those retained 130,525,000 fry of excellent quality were hatched. With the exception of 2,000,000 fry, which were forwarded to a fish and game protective association at Phoenix, Pa., the entire output of the station was returned to the spawning grounds in tributaries of the Potomac River.

BUFFALOFISH.

ATCHAFALAYA (LA.) SUBSTATION.

[C. F. Culler, in charge.]

The work of putting this substation in readiness for buffalofish propagation was taken up on January 17 by a force of detailed employees under the immediate direction of the field foreman of the Mississippi River rescue station. Eggs were taken from February 15 to March 5, but natural conditions in general were unfavorable. The spawning of the fish was retarded and the egg supply curtailed by the prevailing cold weather, and the quality of the eggs secured was impaired by the abnormally low temperature of the water in the hatchery, which at no time during the collecting season attained 56°.

Probably because of the unusually high water stages and the low temperatures prevailing, the fish deserted their customary spawning places almost without exception and sought new ones. On March 5 a considerable rise in the Ouachita River resulted in flooding the surrounding lowlands and polluting the hatchery water with the oily and alkaline substances with which this river appears to be charged. Under such conditions the run of fish in the Atchafalaya immediately ceased and the entire stock of eggs in the hatchery was killed. From that time to the end of the season all eggs taken were fertilized and immediately returned to the spawning grounds from which derived, the number thus treated—128,114,500—including the bulk of the season's collections. The total output of fry amounted to only 5,925,000, these being the product of the earlier eggs taken.

In the course of the season an attempt made to incubate eggs in water from the recently constructed artesian well at this station resulted in failure, the eggs proving a total loss within 24 hours after the test was started. The water appeared to be of an oily nature and was very roily. Its temperature at the well registered 72° F.

The experience gained as a result of two seasons' efforts on the Atchafalaya River would seem to demonstrate the advisability of abandoning the present site and relocating the station at some point where the quality of the water supply for the hatchery is more suitable and dependable. It is believed that such a site can be found in the section north of the Red River, and it is recommended that an inspection of this territory be made in advance of another spawning season.

MARINE FISHES.

At the stations engaged in the propagation of the marine fishes the work during the year was chiefly concerned with the cod, pollock,

haddock, and winter flounder. The aggregate output of these species amounted to 2,733,337.000 fertilized eggs and fry, this number, as compared with that of the previous year, showing a shortage of about 570,000,000. Two important spawning grounds of the winter flounder—in the vicinity of Newport, R. I., and Nantucket, Mass.—were not occupied. Some collections have been made in the former field in the past, but in the absence of a suitable boat none was undertaken last season. No egg collections have ever been made in the Nantucket field, but the information at hand would appear to indicate that with proper facilities very profitable returns might be expected, as hundreds of tons of winter flounder are annually caught around Nantucket and shipped to the market.

Despite a tendency in some quarters to the belief that the artificial propagation of the deep-sea fishes is of little practical value, the general trend of opinion among the more prominent fishermen is favorable to a continuation of the work. Speaking generally, the fishermen are deeply interested and in nearly all cases they are zealous in their efforts to assist the bureau in its egg collections. Some years ago most of the fishermen of this region were opposed to the placing of spawn takers on their boats. Now they not only permit the presence of the spawn takers but assist them in many ways in the conduct of their work.

BOOTHBAY HARBOR (ME.) STATION.

[E. E. Hahn, Superintendent.]

As in past years, everything possible was done during the spawning season to secure eggs of various marine fishes but without success except in the case of the winter flounder. No pollock were obtainable from the Gloucester field, no haddock or cod could be found anywhere along the eastern Maine coast, while alewives came on to the fishing grounds in very small numbers and none of them was in spawning condition.

The usual preparations were made to take up winter-flounder propagation late in February, but all efforts to secure a brood stock at this time were rendered futile by heavy ice fields on the fishing grounds, abundant snowfall, and freezing weather, these conditions predominating up to the beginning of the third week in March. On March 20 the first capture of fish was made, and four days afterwards the first eggs were taken, the spawning season being fully two weeks later than in any preceding year since the station was established. From that time on the outlook brightened. Over 60 fyke nets were scattered over an area extending from Casco to outer Penobscot Bay and were vigorously fished to the close of the spawning period on May 10, the steamer *Gannet* attending the more distant nets, while those within easy reach of the station were looked after by motor boats and dories.

In the course of the season nearly 5,000 brood winter flounder were captured, and as the majority were of unusually large size the egg yield was good, amounting to 943,316,000. These were of uniformly good quality and from them 866,800,000 fry were produced and distributed, the percentage of hatch being a trifle under 92. The fry were sent out in ordinary transportation cans and

planted by means of the station steamer and several motor boats on the spawning grounds from which the eggs were derived.

A peculiarity in connection with the work was the scarcity of winter flounder in Linekins Bay, heretofore the most prolific field covered by the station operations. This year practically no results were obtained from the nets set in the bay, while those in eastern waters yielded a large number of fish of greater than average size.

During the year a large amount of minor repair and improvement work was done on station buildings, boats, machinery, and other equipment, practically all of it being accomplished by the statutory employees attached to the station.

A most interesting and educational exhibit of the marine life of the region was maintained in the hatching room of the station during the summer months and attracted a large number of visitors. The exhibit was discontinued early in September to save fuel.

GLOUCESTER (MASS.) STATION.

[C. G. Corliss, Superintendent.]

A number of important items of repair work were made at this station during the year. New joists and new double flooring were laid in the hatchery and the roof of the building was reshingled. The boiler and pump house was enlarged to permit of the installation of a new horizontal boiler and a better arrangement of some of the machinery. To increase the amount of working space two small wooden extensions set on concrete foundations and conforming in style to the old construction were annexed to the sides of this building, and a concrete pit, 4 by 11 feet in area and 3 feet deep, was built into the extension of the pump room for the condenser and circulating pump.

The outer end of the wharf was extended 9 feet along its entire front, thus giving greater stability to the entire structure and permitting of the projection of the suction line into deeper water. Other needed repairs were made to the foundation of the wharf, and several important changes were made in the steam plant with the view to increasing its efficiency and effecting economy in coal consumption.

In the prosecution of the pollock work the same adverse conditions contended with last year were again in evidence, operating in some respects with even greater force than in 1922, and as a result the collection of eggs was greatly reduced as compared with the average of recent years. There appeared to be an abundance of pollock on the inshore fishing grounds, but, owing probably to food conditions, the fish were constantly shifting about. This not only curtailed the daily catch of fish, but entailed a serious loss of time in resetting the nets.

The unusually small force of spawn takers available for making egg collections was compelled by circumstances to work on smaller fishing boats than formerly and with a few exceptions these boats were equipped with old nets, which had to be favored in bad weather, thus causing the loss of many days when fishing might have been profitably conducted had proper equipment been available. All these factors operated to reduce the egg collections.

The spawning season opened November 11, fully half a month before pending repairs to the steam plant could be completed, and during this period the 33,960,000 eggs taken had to be fertilized and returned to the spawning grounds. In all, 418,950,000 eggs were secured, the last collection being made on February 4, and from the 379,000,000 incubated 275,410,000 fry were hatched and released in suitable coastal waters.

Despite the fact that fishing operations were seriously curtailed by the severe weather prevailing during the winter and early spring, the collection of cod eggs was the largest ever made for the Gloucester station. Though small, the daily receipts throughout December, January, and February were fairly uniform. In March the supply was substantially increased, but the majority of the collections were received in April and May. Inshore fishing was much below the average in volume, the daily catches for the most part running small, but this decline was more than offset by the unusually large numbers of ripe fish taken. The receipts of eggs from the beginning of the spawning season (December 9) to the closing day of the collections (May 24) aggregated 605,960,000, besides consignments to the number of 32,970,000 surplus eggs transferred from the Woods Hole hatchery.

During the period of the spring freshets it became necessary to discontinue shipments from the collecting fields to the hatchery and plant the fertilized eggs on the spawning grounds. The number thus treated amounted to 277,500,000. Including the transfers from the Woods Hole station, 365,450,000 cod eggs were incubated in the hatchery, yielding a total of 245,140,000 fry for distribution.

The season's collection of haddock eggs, made between March 25 and May 11, was the smallest secured in several years. The causes responsible for this were (1) extremely cold weather during the early spring, (2) scarcity of brood fish on the inshore spawning grounds, and (3) the unusually small number of boats engaged in fishing. The spawning season opened extremely late, and while several large captures of fish were made late in March, no ripe ones were among them. At times during the season, weather conditions were so unfavorable that it was impossible to haul the nets for periods of three to five days at a time, and, when finally landed, all the fish taken in them were dead and their eggs a total loss.

Notwithstanding the many difficulties encountered, over 100,000,000 eggs were secured during April and early May, though most of them, owing to the unsuitable condition of the hatchery water at this time, had to be fertilized and immediately returned to the grounds where taken. Only 2,960,000 haddock fry were produced at the station in the course of the season, and these were released in waters near Cape Ann.

There was a great scarcity of winter flounders in Massachusetts Bay during the spring, and in the absence of commercial fishing for that species in the vicinity of Cape Ann, the station was compelled to rely upon fyke nets for its brood stock. The station nets were set as soon as the ice left the harbor, and by this method 194 gravid fish were taken between March 14 and April 27. This stock yielded 78,230,000 eggs, and from them 68,760,000 fry were obtained for distribution.

WOODS HOLE (MASS.) STATION.

[W. H. THOMAS, Superintendent.]

This station experienced the most successful year's work in its history in the propagation of cod, the egg collections of that species amounting in round numbers to 670,000,000, while the output of eggs and fry aggregated 505,153,000, or nearly three times the number produced the preceding year.

Much difficulty was experienced during the fall in effecting satisfactory arrangements for the delivery of brood cod as a source of egg supply. An extended search disclosed that all the fishing vessels heretofore performing this service had either been lost or had taken up other lines of work. However, a small vessel suitably equipped for the purpose was finally engaged to transport cod to be furnished by a trap owner on the commercial fishing grounds, and while the deliveries were sometimes delayed by storms the station secured by this means an exceptionally fine brood stock of 2,812 cod averaging 6.91 pounds in weight. In past years, when purchasing stock direct from the vessel owners making the deliveries, the bureau has found it expedient, in order to retain their full cooperation, to accept all fish landed regardless of sex. Under this year's arrangement it was deemed advisable to effect an agreement with the trap owner to furnish fish in the proportion of 2 males to 3 females. This plan worked so well that it will be followed hereafter.

During the spawning season, extending from late November to the middle of February, 555,584,000 eggs of good quality were realized from the brood stock, this being the largest collection ever made from fish spawning naturally in the station cod basin. In an effort to augment the egg supply, a force of temporary spawn takers was engaged to collect cod spawn in Cape Cod Bay. In connection with this undertaking the station steamer was utilized not only as living quarters for the men but to gather up the spawn and transport it to Sandwich, Mass., from which point it was conveyed to the hatchery by the station truck. As soon as the hatching season opened double service was performed, consignments of fry being taken to Sandwich on the daily trips of the truck and from there transported by the steamer to be planted on the natural spawning grounds from which the eggs were derived. Work in this field extended from October 30 to the end of December, and the egg collections aggregated 114,145,000.

Information was received early in the season to the effect that cod eggs in profitable numbers might be secured in the vicinity of Plymouth and at other points along the Massachusetts coast, but the limited funds available would not permit of the conduct of operations in these areas.

Every season for some years much additional labor has been entailed and unavoidable losses of cod eggs sustained through the clogging of screens on the inner hatching boxes, the trouble usually being much worse during January and February than at any other period. A careful examination conducted by the scientific assistant last season when the difficulty was at its height disclosed the presence in the water supply of immense quantities of diatoms and other minute organisms of many different forms. Enormous numbers of

diatoms were found throughout this region, Buzzards Bay, and Vineyard Sound, and great numbers were carried into Great Harbor (Woods Hole) by the strong currents and winds. It was noticed that after a thaw or heavy rain a considerable increase in the number of diatoms occurred, while repeated observations indicated that this was not a mere coincidence. A possible explanation may be that the drainage from the land increases the necessary food products of the diatom in these local waters. The particular diatom (*Rhizosolenia alata*) that usually interferes with propagation of cod at Woods Hole does not ordinarily occur until the temperature of the harbor water drops to about 35° F. It is not possible to relieve the situation by changing the source of water supply.

The best results are obtained in cod propagation when the water temperature is from 42° to 47° F. Therefore it is proposed hereafter to heat the water used in cod propagation at times when the temperature falls below 47°, and to maintain the supply at a point 5° above the temperature of the harbor water until the cod work is completed. Owing to the arrangement of the heating pipes in the hatchery, this undertaking will entail no additional expense.

As in past years, operations were conducted in Waquoit Bay for the purpose of obtaining a brood stock of winter flounder, this work extending from January 16 to March 20. Though prosecuted with the utmost vigor, the efforts to this end were rendered almost negligible by the difficulties met with. Not only were weather and road conditions such that it was often impossible to attend the nets for several days at a time, but there were very few fish on the spawning grounds. It was ascertained that one 42-foot fishing boat operating just outside the entrance of the bay early in November, just at the time the fish were beginning to enter it, had cleared a profit of $1,400 as a result of 10 days' fishing. This boat must have taken approximately 7 tons of winter flounder, representing about 9,000 fish, and it is possible that to the operations of this and other vessels may be attributed the unwonted scarcity of fish in this field. The efforts to obtain a brood stock of this species were also extended to the Wickford (R. I.) field. Work there was undertaken on March 16, but the returns up to April 4 were so poor that the attempt was abandoned. The total collection of eggs from fish taken in these two fields amounted to only 369,865,000, less than one-third the number secured in 1922.

On February 17, when hatching operations were in full swing, the water supply was shut off by the freezing of the suction pipe. To meet the emergency thus created the Coast Guard steamer *Acushnet* agreed to furnish the water required to keep the hatchery in operation, but at the expiration of 24 hours' service the steamer was obliged to take up other duty and nothing remained to be done but liberate all stock on hand. The plants made at this time consisted of 115,897,000 green eggs, 102,354,000 eyed eggs, 10,000,000 fry, and 400 brood fish, all winter flounder.

The usual efforts were made during the spring to obtain eggs of the mackerel, scup, and sea bass. On several occasions a few eggs of the two first-named species were secured, but in the absence of a fertilizing medium they were of no value.

ANADROMOUS FISHES OF THE ATLANTIC COAST.

The fish-cultural work coming under this head is conducted at three stations and one substation and includes operations with the Atlantic salmon, shad, the river herrings (*Pomolobus æstivalis* and *P. pseudoharengus*), the humpback salmon, and the striped bass or rockfish. The total output of these species during the fiscal year was 183,803,000, an increase of approximately 11,500,000 over that in 1922. The distributions of river herring were nearly doubled as compared with that year, but the production of shad and Atlantic salmon fell short of the usual numbers. This being the off year for the run of humpback salmon introduced in certain coastal rivers of Maine some years ago, no eggs of that species were taken.

SHAD.

BRYANS POINT (MD.) SUBSTATION.

[L. G. HARRON, Superintendent.]

Shad propagation at this station was undertaken under very unfavorable conditions. Cold stormy weather prevailed at the beginning and practically to the end of the spawning period, seriously curtailing the run of fish to the spawning grounds in the Potomac River. Only a comparatively few shad were in evidence when the collection of eggs was undertaken on April 20, but the work was vigorously and continuously prosecuted up to the middle of May, when it was recognized that the run was practically over. It is estimated that about 30,000,000 eggs were delivered at the hatchery, but as it was desired to pay for good eggs only no measuring or recording was done until the second day after their receipt, thus allowing sufficient time for the detection and elimination of any that might be of poor quality. The eggs paid for aggregated 17,627,000. Practically all were of fine quality and from them 16,700,000 fry were hatched, the losses during incubation amounting to only about 3 per cent. All fry hatched were liberated in good condition on the principal spawning grounds in the Potomac River.

During the year a bungalow 14 feet square and 8 feet high was constructed as living quarters for the superintendent. Four new live cars for holding brood yellow perch were built and various minor repairs were made to the hatchery and equipment.

SHAD AND RIVER HERRINGS.

EDENTON (N. C.) STATION.

[W. S. VINCENT, Superintendent.]

As the prevailing public sentiment in this region was in opposition to the issuance of licenses for the operation of gill nets for taking shad within certain restricted areas of upper Albemarle Sound, no permits of this character were issued during the spring of 1923. From the information at hand it appears that during the years when gill netters were allowed to operate on these grounds many unripe shad were taken and sent to the market which otherwise would have

spawned naturally. In recent years these nets have constituted a very uncertain source of egg supply for propagation, as the State laws require their removal by April 25, just when the spawning season is at its height. In view of all the facts in the case it was deemed advisable to discontinue the issuing of licenses and await further developments. As a consequence of this decision the shad work of the Edenton station was limited to the incubation of 250,000 eggs, which were taken while a collection of material was being made for examination by the bureau's scientists. Two hundred thousand fry were produced from this lot and delivered to an applicant at Franklin, Va.

In lieu of the shad work, all efforts were concentrated on the propagation of the river herrings, of which two species, the branch herring (*Pomolobus pseudoharengus*) and the glut herring (*P. æstivalis*) are available. Owing to the cold late spring the spawning season began somewhat later than usual. Egg collections extended from April 9 to May 10, the largest numbers being taken on April 23 and 24. Variable winds kept the run of herring constantly on the move, the fish coming in with the southwest winds and running back with the offshore wind. Notwithstanding this handicap, however, over 313,000,000 eggs were taken, or nearly three times the number secured the previous year.

Very difficult conditions are encountered in the collection of herring eggs. While the owner of a fishing boat desires that the bureau obtain all ripe eggs available, his main object is to get the fish to market, and the spawn taker is sometimes obliged to work so fast that it is impossible to prevent the taking of some immature eggs with the ripe spawn. For this reason there is often a wide margin of difference between the number of eggs collected and the number hatched, and, while a hatch of 90 per cent was frequently obtained during the season, it was much below that taking the work as a whole.

The herring egg is adhesive during the earlier stages of incubation, and all attempts to overcome this adhesion by the use of the starch solution have been of no avail. For the first 24 hours, therefore, the eggs are held in open-top jars and must be stirred almost constantly with a feather to prevent their forming into a solid mass. By the end of that time the developing fish in the egg seems to overcome the adhesive tendency and an increase in the flow of water at this period will give all the motion required to keep the eggs in good condition until incubation is completed. During the past season the period of incubation was 57 hours in an average water temperature of 67°.

In addition to its work with the anadromous fishes the station produced limited numbers of the various pond species. Mention of this work may be found on page 84.

STRIPED BASS.

WELDON (N. C.) SUBSTATION.

[W. S. VINCENT, Superintendent.]

For several years prior to the striped-bass spawning season of 1923 the bureau's work in the propagation of this species had been directed by a temporary employee—a resident of Weldon. The

methods pursued by him having aroused much dissatisfaction, it was decided to discontinue his services and detail one of the statutory employees of the Edenton station to assume charge of the work. It was discovered after the arrival of this employee that in past seasons the local fishermen had been paid at the rate of $20 per million for eggs furnished and had been allowed additional compensation for the time consumed in delivering them at the hatchery. He at once established a price of $20 per million for eggs delivered. This reduction in price, together with the change in management, incurred such ill feeling among the fishermen that they refused for a time to make any egg collections. However, after being thoroughly convinced that the station would be closed if they persisted in their refusal to cooperate, their attitude changed and they began furnishing eggs for propagation, the first delivery being made on May 5.

It was soon discovered, in connection with the prosecution of fish-cultural work at this point, that the waste matter discharged from a paper mill located at Roanoke Rapids was polluting the river water to such an extent that the fry succumbed soon after liberation. Egg collections were at once discontinued and the work was terminated as soon as the stock on hand could be disposed of. During the short period of operations—from May 5 to May 9, inclusive—22,084,000 striped-bass eggs were received at the hatchery and 16,370,000 fry produced and liberated.

ATLANTIC SALMON.

CRAIG BROOK (ME.) STATION.

[J. D. De Rocher, Superintendent.]

A small lot of young Atlantic salmon held over from the hatch of the previous year was carried through the months of July and August, 1922, and then liberated in Dennys River, Me., the distribution comprising 40,000 No. 2 fingerlings. Heavy April rains having washed away the barriers of the Dead Brook inclosure, where brood Atlantic salmon have heretofore been held awaiting the development of their eggs, it was decided to omit the customary purchase of adult stock during June, and, in view of the antagonistic attitude of the salmon-weir fishermen, it is believed that very few of them would have been willing to supply the fish even if the bureau had been in a position to take them. On March 10 a shipment of 500,000 eyed Atlantic-salmon eggs was received from the Canadian Government in exchange for an equal number of brook-trout eggs, this being the third successive year the station has received eggs from that source. Of the resulting fry 451,000 were liberated in tributary waters of the Penobscot River after the absorption of the food sac, and 14,820 were on hand at the close of the fiscal year.

RESCUE OF STRANDED FOOD FISHES.

[C. F. Culler, in charge.]

With the Homer (Minn.) station as a central directing point, rescue operations on the upper Mississippi River were taken up early in July and vigorously prosecuted to the end of October, at which

time shortage of funds compelled the discontinuance of the work though a considerable amount of territory was left wholly untouched. The field in general embraced all lowland areas lying between Prescott, Wis., and Andalusia, Ill. The Homer station and the substations at Marquette and Bellevue, Iowa, and at La Crosse, Wis., were employed as holding and distributing points for the fishes collected in their vicinity. A small amount of rescue work was also done in the State of Louisiana in cooperation with the Louisiana Conservation Commission and at the Friar Point (Miss.) station under the immediate direction of the superintendent of the Tupelo station.

The number of fish handled at all points in the rescue field during the season amounted to 139,799,031, and all of them were released in suitable adjacent waters with the exception of 1,164.952, or less than 1 per cent of the whole. These were shipped to applicants in various parts of the United States by means of the bureau's distribution cars and messengers. The most prolific fields were in the vicinity of La Crosse, Wis., the substation at that point handling 58,135.611 fish in the course of the season and furnishing a material part of the output of rescued fish supplied to applicants. A table showing the number of fish of each species produced and the output from each distributing center may be found on page 11. The average cost of the work per thousand fish rescued was about 19 cents.

In accordance with an agreement entered into with the Louisiana Conservation Commission cooperative rescue operations were taken up in Mississippi River waters of the State on October 23, 1922. After removing the fish imprisoned in barrow pits near Baton Rouge, the men, boats, and equipment were transferred for further work to Bayou Sara, thence to Angola, and finally to the Atchafalaya River in the vicinity of Simmesport. After a careful survey of the conditions at this latter point it was decided that the probable results of the contemplated operations were too small to justify the expenditure involved, and on November 17 the bureau withdrew from the field. As a result of the cooperative work in this territory 451,487 fishes of miscellaneous species were removed from temporary waters and returned to the main channel of the river. For its prosecution the State furnished the use of a launch and a houseboat, to serve as living quarters, and the bureau provided the services of two experienced fish culturists.

The appreciable falling off from the output of the preceding year in the rescue field was the direct result of the natural conditions encountered in the work. Contrary to the usual experience, the flood stage of the Mississippi River was unduly protracted by continuous rains, and the lowlands where spawning occurs were not cut off from the main channel, as in other years, until after a large percentage of the young fish hatched had returned to it of their own accord.

The work was conducted to much better advantage than ever before, as the services of the special rescue personnel recently provided for by Congress were available throughout the season. Under present arrangements the work of the fishing crews detailed to various parts of the field can be personally supervised and directed by men trained in the rescue operations, thus insuring greater efficiency than has heretofore been possible and at the same time effecting a considerable reduction in cost.

MUSSEL INFECTION IN CONJUNCTION WITH THE RESCUE OF LANDLOCKED FISHES.

[H. L. CANFIELD, in charge.]

The infection of rescued fishes with the larvæ of commercial freshwater mussels was undertaken on a large scale and resulted in the release of 2,048,977,910 larval mussels (glochidia) in a state of parasitism on the gills of host fishes. This total, representing by far the largest amount of mussel-infection work ever accomplished in a single year, was done at a very considerable reduction in cost as compared with that of the previous year, the average per thousand glochidia being only $0.0025. By combining the operations connected with the rescue and the mussel-infection work it has been possible to produce enormous quantities of juvenile mussels at a low cost, and the clam fishermen and others engaged in the industry have cooperated with the bureau to the fullest extent to make the work a success. The following table summarizes the mussel work of the bureau during the fiscal year 1923, showing the fields in which operations were conducted and the numbers and species of mussels handled in each.

Extent of mussel-propagation work in 1923, showing fields of operation and numbers and species of mussels handled in each.

Field.	Grass mucket. (*Lampsilis luteola.*)	River mucket. (*Lampsilis ligamentina.*)	Pocket-book.[1] (*Lampsilis ventricosa.*)	Total.
	Number.	*Number.*	*Number.*	*Number.*
Minneiska, Minn.	30, 209, 500	14, 506, 500		44, 716, 000
Winona, Minn.	70, 060, 000	13, 500, 000		83, 560, 000
Homer, Minn.	58, 338, 000	3, 235, 000	1, 798, 300	63, 371, 300
Dakota, Minn.	4, 082, 500	5, 343, 000		9, 425, 500
La Crosse, Wis.	61, 853, 750	860, 500		62, 714, 250
Brownsville, Minn.	67, 579, 750	21, 193, 350	36, 000, 500	124, 773, 600
Genoa, Wis.	97, 070, 000	121, 310, 000	64, 375, 000	282, 755, 000
Ferryville, Wis.	63, 800, 000	21, 350, 000		85, 150, 000
Lynxville, Wis.	614, 763, 000	68, 472, 500		683, 235, 500
Marquette, Iowa	13, 600, 000			13, 600, 000
Guttenberg, Iowa	20, 565, 000	28, 567, 500		49, 132, 500
Bellevue, Iowa	255, 635, 610	143, 451, 100	18, 243, 500	417, 330, 210
Rock Island, Ill.	67, 275, 500	35, 201, 550		102, 477, 050
Gordons Ferry, Iowa	26, 737, 000			26, 737, 000
Total	1, 451, 569, 610	476, 991, 000	120, 417, 300	2, 048, 977, 910

[1] This mussel is not first class in quality, and fishes are infected with it only when first-class mussels are not available.

FISHES OF MINOR INTERIOR WATERS.

Under this general head is included the work of the Rocky Mountain trout stations, the New England trout and salmon stations, the combination trout and pond fish-cultural stations, and that group of stations devoted exclusively to the production of warm-water pond fishes. The fishes propagated at these stations are, as a rule, distributed to applicants, but considerable numbers, especially of the black-spotted trout, are returned to the waters from which the eggs are derived. Since the advent of the automobile and the extensive opening up of roads in formerly inaccessible regions, many streams

that originally teemed with game fishes have become practically depleted, while others would become so were it not for the efforts made by the bureau and the various State fisheries departments to keep up the supply. This depletion of fish life, especially of the brook trout, in so many of the streams of the country has increased the demands upon the bureau for eggs and fry of this species out of all proportion to its available supply.

In connection with its work of propagating the brook trout the bureau has found it necessary to purchase from commercial dealers the bulk of the eggs used for stocking its hatcheries. In many cases eggs from this source are of poor quality and the fry resulting from them lack the vitality inherent in fry derived from wild fish. In view of the situation the bureau has been endeavoring for the past year or two to establish, on a promising site at York Pond, N. H., a plant capable of producing sufficient brook-trout eggs to fill its needs. Work on this plant is being pushed to completion as fast as the available funds will permit.

Other fishes for which large demands are annually made are the black basses, both the largemouth and the smallmouth species. With the present facilities for their production it is practically impossible to produce them in sufficient numbers to meet the requirements, and the urgent need for the extension of this branch of the work is clearly apparent.

ROCKY MOUNTAIN TROUT STATIONS.

This important group is composed of eight stations and substations, located in the States of Colorado, Montana, South Dakota, Wyoming, and Utah. The year's work of the group was most successful, especially as regards the propagation of the black-spotted trout, the output of which was more than five times as large as that of the preceding year. The total output of these stations in eyed eggs and fry during 1923 aggregated 22,364,540, the species handled including black-spotted trout, brook trout, rainbow trout, and small numbers of Loch Leven and steelhead trout.

BOZEMAN (MONT.) STATION AND SUBSTATIONS.

[W. T. Thompson, Superintendent.]

Fish-cultural work at Bozeman station and its auxiliaries consisted in the propagation of brook, rainbow, black-spotted, and lake trout and the steelhead salmon. The majority of the eggs handled were taken in outside fields, only 1,610,000 being secured in local waters, while the year's output from this group of stations aggregated nearly 2,000,000 fingerling fish and 1,389,000 eyed eggs, the latter, at the request of the National Park Service, being deposited in waters of Glacier Park which it would be impossible to reach with fry owing to their inaccessible location.

BOZEMAN (MONT.) STATION.

During the year the Bozeman hatchery received from outside sources 1,285,000 brook-trout eggs, of which 250,000 were purchased from a commercial dealer. The remainder was contributed by the

Springville (Utah) and Leadville (Colo.) stations. From these eggs, together with 90,000 collected from brood trout in the station ponds, 1,271,000 fry were hatched, or nearly 92½ per cent of the original stock. Quite heavy losses occurred during the spring, due principally to the impossibility of securing fresh supplies of liver at all times. Notwithstanding this difficulty the output of brook trout exceeded 900,000, about two-thirds of them being fingerlings, and nearly 500,000 were on hand at the close of the year.

This station also received 1,450,000 black-spotted-trout eggs from collections made in the Yellowstone National Park, 338,000 rainbow-trout eggs from its Meadow Creek auxiliary, 75,000 lake-trout eggs from the Duluth (Minn.) station, and 58,000 steelhead eggs from Oregon. Of this stock eyed eggs of the rainbow and black-spotted trouts to the number of 150,000 were reshipped to applicants. The remainder was developed with not more than normal losses, furnishing an aggregate output of 981,600 fingerlings and fry and leaving on hand at the close of the year a material percentage of the original number to be reared to a larger size before distributing.

Quite extensive alterations were made to the ponds at Bozeman station during the year with the view of eventually reconstructing the entire system as funds permit. In pursuance of a carefully devised plan ponds Nos. 1 to 18, located in swampy ground, were converted into six rock and gravel-bottom inclosures, each approximately 90 feet long, 31 feet deep, and 4 feet 7 inches wide at the bottom, with a slope sufficient to give a width of 5 feet 7 inches at the top. These ponds are so arranged that when their dams are drawn all bottom sediment is swept by the heavy current toward the lower end, assisting very materially in cleaning operations. Screens extend across the entire pond areas and the outlet boxes in the sides are fitted with both screens and dams. It is intended later to lengthen these ponds to approximately 175 feet by throwing into them the space now occupied by the remaining 18 ponds of the old series. Each of the six ponds will then be provided with full-width dams and screens to form two or more inclosures at will, in accordance with the needs of the work. When the entire nursery system has been reconstructed the available supply of spring and creek water will be arranged to flow through the entire length of the ponds.

MEADOW CREEK (MONT.) SUBSTATION.

Rainbow trout operations at the Meadow Creek substation were greatly obstructed by the preparations being made by the Montana Power Co. to build a bridge across the stream. In connection with this project the water level in the creek was maintained at so low a level throughout the entire spring that many of the ascending trout were forced to turn back and seek spawning grounds elsewhere. Egg collections were therefore curtailed, the total amounting to only 1,520,000. The spawning season was from two to three weeks shorter than the average, extending only from April 23 to the end of May, and the losses of eggs were unusually heavy, only 810,000 or 54 per cent of the collection surviving to the eyed stage. Three hundred thousand of the eyed eggs were hatched at the substation with the view of returning the product as fingerling fish to the home

spawning grounds. The remaining eggs were used for stocking the Bozeman and Glacier Park hatcheries.

GLACIER NATIONAL PARK (MONT.) SUBSTATION.

Approximately 215,000 steelhead and rainbow-trout fingerlings that had been carried over from the hatch of the preceding year in the Glacier Park hatchery were liberated in July in suitable streams within the park, and there were on hand at the close of the year 85,000 eyed eggs and 70,000 fry of the rainbow trout, these being the result of a shipment of eggs from the Madison Valley field early in June.

An interesting and important feature of the work in this region was the planting of eyed black-spotted trout eggs in the almost inaccessible waters in that part of the park lying along the crest of the Continental Divide and the Canadian border. The trip was made on horseback and the planting was done by the superintendent of the station assisted by two of the park rangers. All facilities for the trip having been provided by the National Park Service, including the loan of saddle and pack horses, the start was made from Bozeman on August 4. In the course of the trip, which consumed 16 days, a total of considerably more than a million eggs was planted in the headwaters of numerous lakes and streams that could not otherwise have been reached. Among the waters thus stocked were the St. Mary River and its tributaries, Hidden Lake, Lake Ellen Wilson, Grinnell Lake, Belly River, Lois, Margaret, and Glenns Lakes, and numerous smaller streams.

LEADVILLE (COLO.) STATION.

[C. H. Van Atta, Superintendent.]

In connection with the propagation of brook trout, the principal species handled at this station, the usual egg collections were made on shares from privately owned lakes, the total stock secured during the season amounting to 6,690,000.

Many of the fish entering the traps in the Engelbrecht field were found to be badly afflicted with fungus, this trouble being due, it is thought, to the abnormally low stage of water in the lake during the summer and fall. However, no bad effects were discernible in either the eggs or the resulting fry, all of which seemed to be of uniformly good quality.

At Turquoise Lake, where nearly half the season's stock of brook-trout eggs was secured, the work was hampered by unusually cold weather. A coating of ice from 4 to 8 inches thick formed on the lake before any collections were made, and in order to gain access to the brood fish a seine had to be threaded through holes cut in the ice at frequent intervals. Some difficulty was also experienced at this point from a scarcity of male fish. Females were in the majority from the beginning, the disparity in numbers increasing as the season progressed, and toward the close of the spawning period females predominated to such an extent that fully 600 brood fish containing partially ripened eggs had to be released because of a lack of fertilizing medium.

When the eggs had reached the eyed stage shipments to a total of 1,225,000 were forwarded to applicants and to other stations of the bureau, one consignment of 50,000 going to Alaska. The incubation period of those held in the hatchery was completed by the end of April, the number of fry produced amounting to 4,767,770, or approximately 88 per cent of the retained stock. In addition to the egg shipments the year's output of this species consisted of 3,345,000 fry and fingerling fish, and at the close of the year a considerable number of fingerlings were still on hand. The brook-trout fields occupied during the year, the number of eggs secured in each, and the dates between which egg collections were made were as follows:

Field.	Number of eggs taken.	Spawning season.
Carroll	443,000	Oct. 29 to Nov. 16.
Engelbrecht	2,193,000	Sept. 24 to Nov. 26.
Evergreen	6,000	Oct. 26 to Nov. 22.
Fred Neal	164,000	Nov. 17 to Nov. 26.
Musgrove	880,000	Oct. 26 to Nov. 22.
Turquoise	3,004,000	Oct. 19 to Nov. 29.
Total	6,690,000	

An output of 671,000 fry and fingerling black-spotted trout, the product of 750,000 eggs of that species received in the summer of 1922 from the Yellowstone Park station, was distributed during the fall to applicants in Colorado, Arizona, and New Mexico. The year's distributions also included 196,150 fingerling rainbow, Loch Leven, and lake trout, the output of the first two resulting from eggs secured in the brook-trout fields, while the lake trout were derived from a shipment of 150,000 eggs forwarded from the Duluth (Minn.) station the previous winter. From a shipment of 50,000 steelhead eggs forwarded from one of the bureau's Oregon substations 45,800 fry were hatched and were on hand at the close of the fiscal year.

YELLOWSTONE NATIONAL PARK (WYO.) SUBSTATION.

[C. B. Grater and C. F. Culler, in charge.]

The fish-cultural season at this station involves a portion of each of two fiscal years, and the part occurring in June, 1922, has been covered in the report for that year. From July 1 to the close of the season in September, 1922, operations were supervised by C. B. Grater, superintendent of the Leadville (Colo.) station. Very successful work was accomplished during the summer of 1922. The black-spotted trout egg collections aggregated 16,751,920, and a large proportion of the fry resulting from the eggs were liberated in various streams within the reservation. In connection with the fish-cultural operations a considerable amount of repair and improvement work was accomplished, among the most important items being the entire rebuilding of the trap on Clear Creek, which was located 18 inches deeper in the creek than was the one it replaced.

During the spring and early summer of 1923 the park work was directed by C. F. Culler, district supervisor. The Soda Butte hatchery was opened on May 23, as the first eggs of the season are usually obtainable in that field, and work at the main station was taken up two days later. At the close of the fiscal year 4,794,000 black-spotted-trout eggs had been secured, and the indications seemed to point to one of the most successful seasons ever experienced in this region.

SARATOGA (WYO.) STATION AND SUBSTATION.

[O. N. Baldwin, Superintendent.]

The bureau's fish-cultural work in Wyoming consisted in the propagation of four species of trout—brook, rainbow, Loch Leven, and black-spotted—and, with the exception of the last-named species, all eggs handled during the year were collected either from domesticated stock carried in the ponds at Saratoga or from wild fish captured in the vicinity of its field auxiliaries.

The small number of brook-trout fingerlings on hand at the beginning of the fiscal year was distributed in September, and during the fall the brood trout at the station yielded 307,000 eggs. This stock was supplemented by the collection of eggs from wild trout taken in Big Creek Lakes, 90 miles distant. Though located in the Hayden National Forest, these lakes are at the present time under the jurisdiction of the Bighorn Land & Cattle Co. The manager of this company appeared to resent the bureau's activities, but through the intervention of local officials of the United States Forest Service an arrangement permitting the bureau to make egg collections in the lakes was finally effected. However, the work was interfered with later, the racks being removed by unknown persons and large numbers of brood fish allowed to escape. Through this occurrence the egg collections were curtailed from approximately 1,000,000 to 288,000. The output of this species for the year amounted to 138,100, and nearly 400,000 fingerlings were on hand at its close. It is the intention to return a substantial percentage of these to Big Creek Lakes with the view of building up the field as a future center for egg collections.

Shortly after the beginning of the fiscal year the rainbow-trout fry resulting from the cooperative work of the bureau and the Wyoming fishery department at the Sage Creek auxiliary were planted in suitable waters and the substation closed for the season. As soon as possible after its reopening in April, racks and traps for the interception of the early run of rainbow trout were installed in Lost, Sage, and Canon Creeks, but owing to the prevailing low water stages the run of fish was unusually light. Between May 1 and June 7 eggs to the number of 1,237,150 were taken, approximately 620,000 of which were furnished, when eyed, to the State fisheries departments of Wyoming and South Dakota. The remainder was developed at the substation with the view of replenishing and increasing the stock in parent streams.

The hatchery erected at Sage Creek last year is a log structure, 38 by 28 feet in dimensions, with hip roof. It is equipped with 24 wooden troughs, 16 feet long, 14 inches wide, and 9 inches deep, and each trough is divided into eight compartments by saw cuts and

iron dams. The hatchery has a total capacity of 5,000,000 green eggs or 1,125,000 fry. As the water supply is derived from the heavy snowfall in the surrounding mountains, it is very roily at times. For this reason the tray system is used, it being necessary to handle the eggs almost daily.

A considerable amount of construction work will be required for the completion of this substation, and the racks and traps in all streams where egg collections are made must have concrete foundations. This part of the work will be done before the beginning of next season's fish-cultural operations, provided funds are available for the purpose.

In addition to its work with the brook trout and rainbow trout, the Saratoga station produced and distributed 87,500 black-spotted trout fingerlings, the product of approximately 100,000 eggs transferred from Yellowstone Park, and from a few Loch Leven trout held in ponds 15,000 eggs were taken and hatched. The resulting fingerlings are to be reared and retained for increasing the station brood stock of this species.

All available funds in the special appropriation having been exhausted by the building operations of the preceding year, no construction work other than minor repairs was possible though much still remains to be done to complete the Sage Creek hatchery and its water-supply system. The matter of improving the station grounds at Saratoga is one that urgently demands consideration. With the exception of a small strip of fenced land along the east side of the railroad these grounds still remain in their original wild condition, cattle roaming over them at will. The reservation should be inclosed by a substantial fence and the grounds planted in trees, shrubs, and grass.

SPEARFISH (S. DAK.) STATION.

[D. C. Booth, Superintendent.]

Construction work formed a very important part of the activities at this station during the year. The old plank ponds Nos. 1 to 12, which were built in 1899, had never given satisfactory service even when an abundance of spring water was available, and after the decrease in the supply of water on the upper level of the station reservation these ponds were of no value whatever. In order to provide space for storing water to be used during periods when a shortage in the city supply curtailed the amount delivered at the hatchery it was decided to tear out these unsightly plank ponds and utilize the space for the location of a suitable concrete reservoir. In pursuance of this plan ponds Nos. 1 to 8 were torn out, the space excavated to a suitable depth, and a substantial concrete wall, reinforced by one-half inch rods laid in cement, was constructed. This reservoir will hold 400,000 gallons of water, or a sufficient amount to tide the hatchery operations over for a period of several days in the event of an accident to the main water pipes or when overflow water from the city reservoir is not obtainable. Another important piece of construction work accomplished was the rebuilding of the large stone bulkhead wall along the southeast corner of the station grounds, the old one having been badly damaged by floods.

The results attained in the fish-cultural work were quite satisfactory, there being no disease among the stock and no abnormal losses. Brook, Loch Leven, and rainbow-trout eggs totaling 1,159,400 were incubated, from which 968,000 fry were hatched, the percentage of hatch being nearly 83½.

Of the brook-trout eggs handled 262,100 were collected from wild fish secured in local streams, 259,600 were transferred from the Springville (Utah) station, and 500,000 were obtained through exchange, the South Dakota fisheries authorities turning over to the station 500,000 eggs that had been purchased by the State from a commercial establishment in Pennsylvania, with the understanding that the State would be furnished an equal number of rainbow-trout eggs from another station of the bureau. These commercial eggs were of fine quality and the fry resulting from them were so exceptionally healthy and vigorous that 100,000 of them were selected and successfully used in the conduct of an experiment made for testing the comparative value of a certain commercial brand of fish food. The year's distribution of brook trout consisted of 792,445 fingerlings No. 1½, and 19,465 were on hand at the end of June.

Nearly 65,000 Loch Leven trout eggs were taken during the fall—12,300 from wild fish secured in connection with the brook-trout egg collection and the remainder from domesticated fish in the station ponds. During January 10,350 were shipped in the eyed stage to the St. Johnsbury (Vt.) station, and the young fish hatched from the remainder will be reared for increasing the station brood stock.

From domesticated rainbow trout held in the station ponds 72,900 eggs were taken, the spawning season extending from January 22 to May 9. Of the resulting fingerlings 35,360 were delivered to applicants late in June. The remainder of the lot was retained for later distribution.

The work at this station also included the handling of 50,935 steelhead-salmon eggs furnished from the Washougal (Wash.) field. This lot was hatched with a loss of about 7 per cent, and all of the resulting fry were being held at the close of the year for distribution in the fingerling stage.

SPRINGVILLE (UTAH) STATION.

[CLAUDIUS WALLICH, Superintendent.]

Fish-cultural work at this station was confined to the propagation of brook and rainbow trout, the output of which was considerably reduced in comparison with the output last year owing to the limitations imposed upon the bureau's operations in the Fish Lake field. Cooperative work between the bureau and the State was undertaken in this region in late October. On arrival there it was found that large numbers of brook trout had already assembled below the mouth of Twin Creeks, where most of the collections are made, but were prevented from entering the stream on account of the unusually low water level in Fish Lake. This condition was remedied by enlarging and deepening the mouth of the stream, after which racks and traps were installed. Spawn taking began on October 27, and from that date to the end of November eggs were taken almost daily,

the total collection amounting to 8,250,000. The State turned over to the bureau 3,200,000 eggs, of which stock 1,500,000 in round numbers were shipped in the eyed stage to other stations of the bureau, over 500,000 going to the Bozeman (Mont.) hatchery.

A number of the stations receiving these eggs, including Springville, sustained unusually heavy losses prior to the hatching period, though the fry resulting from them appeared to be normal. The losses may be attributed in part to the fact that many of the eggs were taken late in the season. It has also been noted, with reference to this field, that eggs stripped from fish the second time are not of the best quality. Of the 522,000 eyed eggs retained at the Springville hatchery 83,000 were lost in the course of the incubation period, while the losses in the fry and fingerling stages aggregated 128,900. Shipments of fingerling brook trout to the number of 248,850, in the Nos. 2 and 3 stages, were made before the end of the fiscal year and 61,250 were carried into the succeeding year. The year's output of this species also included 33,600 No. 4 fingerlings, the product of the previous year's egg collections. These were distributed in July, 1922, most of them being returned to Fish Lake and its tributaries.

The stock of rainbow trout on hand at the beginning of the fiscal year included 637,000 fingerlings No. 3, which were distributed in July, 1922, and also 344,000 fry resulting from the spring egg collections. The fry did well until about the second week in August, when an abnormal mortality occurred and continued for some time. No definite cause could be ascribed for it. The entire lot was being carried in the hatchery, which was supplied with intake water, all surface water being excluded, and every effort was made to keep the stock in a sanitary condition. The food used was beef hearts, inspected, to which a small proportion of mush was added. The trouble first became evident through the fading of the fish to lighter shades. They gradually refused to eat, became emaciated, and assumed a heady appearance. The center of affection did not seem to lie in the gills. As a rule the losses were larger in troughs where water was being used a second time. The subsidence of the disease seemed to be coincident with the admission of surface water into the intake reservoir and the transfer of the stock to the concrete pond system, and by the middle of September, when the distribution of the fish was taken up, the survivors were in good condition. The output from the lot consisted of 169,300 fingerlings Nos. 2 and 3.

With the view to profiting by the experience gained the 508,000 fry resulting from the rainbow brood stock the following spring were transferred to the concrete pond system and subjected to the conditions that seemed to have afforded relief to the former lot, but without avail. Though a remarkably healthy and active lot of fish during the earlier stages of their growth, they were attacked by a somewhat similar epidemic when about 1½ inches long, but with this difference: Fish that apparently were in good health one day would be lying dead in windrows up and down and through the center of the ponds on the succeeding day. After continuing heavy for a few days the death rate would decrease, but almost every lot of the fish was similarly affected on attaining the length mentioned. The total losses on this stock amounted to 314,000. Of the remainder 124,000 were distributed as Nos. 2 and 3 fingerlings before the end of the year and 70,000 were on hand at its close.

Under an agreement effected with the Utah fisheries authorities the station participated with the State in the collection of rainbow-trout eggs from wild fish in the Fish Lake field during May and June and received one-fifth of the proceeds as its share. The quality of these eggs was about the average of the stock secured in this field. After shipping 25,000 eggs to the Manchester (Iowa) station the remainder was hatched, producing 310,000 fry, all of which were on hand at the end of June.

Complete failure attended the efforts put forth to collect eggs in the Kyune Reservoir, near Colton, Utah, where the bureau has recently been making annual plants of rainbow trout with the view to building up an egg-collecting source. The two trips made to this point—one in March and the other in May—failed to disclose the presence of any brood fish whatever. It is feared that this 13-acre lake is almost too small to warrant any profitable returns in eggs, but a few rainbow fingerlings will be liberated there annually for a while and a close watch kept on the results.

Having failed for two successive years to secure any results from the experiment undertaken some time ago with the object of determining the feasibility of holding a brood stock of native trout in the station ponds as a source of egg supply, it was decided to liberate the fish in suitable waters and abandon the attempt. The number of eggs taken in each instance was negligible and their quality was very poor.

NEW ENGLAND TROUT AND SALMON STATIONS.

Included under this head are the stations located at Hartsville, Mass., East Orland, Me., St. Johnsbury, Vt., and Nashua, N. H., together with their several auxiliary substations. During the past year the former station at Green Lake, Me., was reduced to the status of a substation and placed under the direction of the official in charge of the Craig Brook station at East Orland. Although the work in this field was interfered with to some extent by unseasonable climatic conditions the results attained at these stations were very satisfactory, their aggregate output being more than 100 per cent greater than in 1922.

BERKSHIRE (MASS.) STATION.

[W. A. Casler, Superintendent.]

The year's fish-cultural work at this station consisted mainly in the incubation of eggs of the brook trout, rainbow trout, and pike perch, and the rearing and distributing of the resulting fish, the aggregate output of which amounted to 754,400 fry and fingerlings.

During the spawning season of the adult brook trout held in the station ponds 203,750 eggs were obtained, of which 149,260, or about 73 per cent, were hatched. This low percentage of hatch compares favorably with the results of recent years at this point and is attributed by the superintendent to the advanced age of the brood stock. A lot of 247,000 brook-trout eggs purchased from the establishment of a commercial trout breeder was apparently far superior in quality to those produced at the station, fry in excess of 240,000 being

realized on the consignment. The two lots of fish were kept separate to the end of the fry stage, when they were thrown together owing to lack of space and because there appeared to be no advantage in their further segregation. For some time after commencing to feed the fish continued to develop normally, but in the latter part of March mortality suddenly increased, the daily death rate rising from about 134 per day to a maximum of 4,500 per day during April.

The disease could not be checked by any of the methods usually and sometimes successfully employed, and the losses up to the time the disease had run its natural course amounted to 151,255, or about 40 per cent of the fry hatched. No satisfactory explanation of this heavy mortality can be given, though the fish-culturist in immediate charge of the work has advanced the theory that surface drainage from the melting of an unusually heavy fall of snow may have carried into the spring supplying the hatchery water some substance deleterious to young fish. In support of this theory he cites similar conditions as to snowfall that existed in the fiscal year 1919. During that year disease broke out among the trout fry and caused an even greater mortality.

In December, 1922, two consignments of rainbow-trout eggs aggregating 108,500 were received from the Wytheville (Va.) station. Being of inferior quality these eggs sustained a loss of almost 40,000, or about 37 per cent, up to the hatching period, and subsequent losses among the fry and fingerlings so reduced the stock that only 45,900 fingerlings were realized, of which number 1,500 were on hand at the close of the year. Early in May a consignment of 500,000 eyed pike-perch eggs arrived from the Put in Bay (Ohio) station. Though delayed in transit the eggs were of exceptionally fine quality and from them 485,000 vigorous fry were hatched and distributed.

Nothing in the way of the much-needed repairs and alterations referred to in previous reports has been possible at this station, the only construction work accomplished during the year being of a minor routine character. Since the bureau acquired title to the Berkshire property in 1915 it has not been possible to divert a sufficient amount of the reduced appropriations from other and more important work to place the station in the condition in which it should be maintained. At the present time much of this property, especially the pond system, is very much dilapidated. The need is for sufficient funds to completely rebuild and rearrange the pond system, which was originally designed for private use and never intended for the production of fish or eggs on the extensive scale required in the bureau's work. While it is recognized that the work of this station can never be made to compare favorably with that of stations more advantageously located with reference to water supply and certain other essentials, it is apparent, nevertheless that if certain changes and improvements can be effected the station can, under skillful management, be made to play an important part in fish-cultural work and can be depended upon to produce for local distribution at a moderate cost certain species of fish that are now being furnished from more distant hatcheries at considerable expense and with some difficulty.

CRAIG BROOK (ME.) STATION AND SUBSTATIONS.

[J. D. De Rocher, Superintendent.]

That part of the fish-cultural work of the Craig Brook station that was addressed to the propagation of Atlantic salmon is discussed in connection with the anadromous fishes of the Atlantic rivers on page 55.

During late December and early January a total of 1,303,700 eyed brook-trout eggs was received from three commercial hatcheries located in Pennsylvania and New England. Of the first consignment, received from a hatchery in Maine, 131,666 eggs were reshipped to the Grand Lake Stream substation. The remainder of this lot—658,334—was incubated at the station, producing a hatch of 96 per cent. Later losses were large, however, over 9 per cent of the young fish having perished before the completion of the distribution in late June. From 210,700 eggs of fine quality received from a Massachusetts hatchery 202,651 fry were hatched. Of these, 155,800 were distributed in the advanced fry and fingerling stages and 24,995 were on hand at the close of the year. The eggs from the Pennsylvania hatchery were too far advanced for shipment when forwarded and some of them hatched on the trays en route. While the percentage of hatch on the remainder was nearly normal the subsequent losses were excessive, the mortality up to the time of distribution amounting to fully 50 per cent.

Fifty thousand rainbow-trout eggs forwarded in December from the Wytheville (Va.) station appeared, on arrival, to be in fair condition. It developed later that they were of poor quality, nearly half the lot being lost in process of incubation, while the fry hatched were weak and all of them perished within a short time.

During the month of March 380,602 eyed landlocked-salmon eggs were received from the Grand Lake Stream substation, of which number consignments aggregating 117,570 were reshipped to applicants in Vermont, New Hampshire, Idaho, and Michigan. From the remaining eggs 223,000 fry were hatched and distributed and 26,820 were on hand at the end of June.

All of the buildings at this station were wired for electric lights during the year.

GREEN LAKE (ME.) SUBSTATION.

Fish-cultural operations at this substation were concerned principally with the propagation of the landlocked salmon and the smelt, the latter including the American smelt (*Osmerus mordax*) and a subspecies (*O. mordax spectrum*) locally known as the "small smelt."

On November 1 traps were placed at the mouth of Great Brook for the capture of brood landlocked salmon, and between the 9th and the 22d of that month 193,000 eggs were taken. These were of uniformly good quality and from them 178,480 fry were hatched and distributed.

The egg collections of smelt were the largest in several years. The spawning season of *O. mordax* began on March 25 and ended April 15, while the spawning of the subspecies extended from the 5th to the 20th of May. In all, 46,300,000 eggs were taken, of which

42,000,000 were of the subspecies. Heavy rains and melting snow caused the bursting of the supply pipe of the smelt battery on April 29, necessitating the immediate planting of all eggs on hand. Fortunately, all of them had about reached the hatching stage and planting at that period therefore occasioned little loss.

One hundred adult smallmouth black bass, captured in traps in Green Lake during July, 1922, were held in the station ponds until fall and then delivered to an applicant at Norway, Me. These bass inhabit Green Lake in considerable numbers, and being considered undesirable on account of their tendency to prey upon the landlocked salmon their removal is generally approved of by residents of that section.

GRAND LAKE STREAM (ME.) SUBSTATION.

Approximately 93,000 landlocked-salmon fry were on hand at the beginning of the fiscal year 1923. Shortly before that date these fish had been placed in the recently constructed ponds in the canal, which was formerly used for the passage of boats in Grand Lake Stream, and immediately afterwards the death rate among them declined noticeably. The young fish were fed as frequently as they would take it readily on a mixture composed of two-thirds beef heart to one-third sheep liver finely ground, and late in July, after 45,000 of them had been liberated, it was observed that the remainder were obtaining sufficient natural food to satisfy them. They continued to grow rapidly and about the last of August all that remained in the ponds were liberated in Grand Lake Stream as fingerlings No. 3, the lot numbering 46,400. The first landlocked-salmon eggs from Grand Lake Stream were secured on October 31 and the last on November 18, while the collecting season at Dobsis Lake extended from the 1st to the 14th of November. In all, 423 female and 818 male fish were captured, from which eggs to the number of 659,350 were taken. Of these, two shipments, aggregating 380,602 eyed eggs, were forwarded to the Craig Brook station. On April 19 the Grand Lake Stream substation received 200,000 eyed landlocked-salmon eggs from the State hatchery at Caribou, Me., this shipment resulting from an agreement previously made with the Maine commissioner of inland fisheries and game to insure the return to parent waters of at least 75 per cent of the product of all egg collections. Owing to flood conditions following the breaking of the gate of the dam at the head of the canal on May 6, all salmon had to be disposed of in the fry stage, the plants being made in Grand Lake and tributary waters.

In addition to the work with the landlocked salmon the station handled a shipment of 131,666 commercial brook-trout eggs, which were reshipped early in January from the Craig Brook station. Owing to the accident referred to above all of them were liberated in the advanced fry stage in Grand Lake and other local streams.

The bureau's present policy of providing brook trout for Grand Lake and neighboring waters has already shown good results. It was very noticeable during the past season that good brook-trout fishing was to be had in all the streams in this section, such waters having formerly been denuded of that species. They now appear to contain young brook trout in abundance, to the intense satisfaction of the local public.

ST. JOHNSBURY (VT.) STATION AND SUBSTATIONS.

[A. H. DINSMORE, Superintendent.]

The fishes propagated at this station and its auxiliaries at Holden, Vt., and York Pond, N. H., included brook, lake, rainbow, and Loch Leven trout, landlocked salmon, and steelhead, the total annual output for the group amounting to nearly 1,500,000 eggs, fry, and fingerling fish. Owing to shortage in operating funds the propagation of pike perch at the Swanton (Vt.) substation was omitted.

ST. JOHNSBURY (VT.) STATION.

Of the 1,323,400 brook-trout eggs acquired for stocking the St. Johnsbury hatchery 450,000 in round numbers were purchased from a commercial trout establishment. The remainder was collected from fish taken in Darling Pond and Lake Mitchell, in Vermont, on the same terms as last year, the bureau collecting and incubating the eggs and receiving as compensation one-third of the eyed eggs produced. The fry resulting from the remainder were placed at the disposal of the owners of these waters. The work with this species also included the incubation of 100,000 eggs that were purchased and delivered at the hatchery by a local fish and game club whose members distributed the resulting fry in various waters of the region.

Other egg receipts were 238,350 of the lake trout, derived from collections at Lake Dunmore, Vt.; 20,350 landlocked-salmon eggs, transferred from the Craig Brook (Me.) station; 10,350 Loch Leven trout eggs, acquired by exchange from a commercial fish-culturist; and 49,500 steelhead eggs received from the Washougal (Wash.) collecting station. Some of the lake-trout eggs were reshipped to the York Pond auxiliary, and a consignment of 50,000 was forwarded to the Nashua (N. H.) hatchery. The remainder was hatched and distributed as fry in suitable local waters. The fry resulting from the landlocked-salmon eggs were transferred to York Pond to be reared, and the product of the Loch Leven and steelhead eggs was on hand at the close of the fiscal year.

On account of limited funds and the need of all possible additional help for the development of the York Pond substation, no work in the propagation of smallmouth black bass was undertaken during the year.

HOLDEN (VT.) SUBSTATION.

The outcome of the year's work in fish culture at this substation was very satisfactory. Only normal losses of stock were sustained and an entire absence of the affection that in recent years has caused such heavy mortality among the eggs and young fish gives ground for the hope that the difficulty has been solved through the application of the recently devised method of aerating the hatchery water supply.

The small stock of fingerling fish of various species on hand at the beginning of the year was distributed in the early fall, and during October and November the bureau and the State fisheries

department were engaged in cooperative work in the collection of lake-trout eggs in Lake Dunmore. The returns from this work were the largest ever secured, the total collections amounting to 684,620 eggs, of which 580,600, or nearly 85 per cent, were eyed. Fifty thousand of the bureau's half of this stock were retained at the Holden station for development, and the remainder was forwarded to the St. Johnsbury station. Brook-trout eggs to the number of 250,000, purchased from a commercial fish-culturist and delivered in January, were held in brook water with a small admixture of spring water to keep them from freezing. From this consignment 238,400 healthy fry were hatched and distributed.

YORK POND (N. H.) SUBSTATION.

During the summer months a large amount of work was done at this substation in the way of improvements to the proposed pond system, with the view of developing it at the earliest possible date into a source of supply for brook-trout eggs for stocking various hatcheries of the bureau.

Diverting ditch No. 1 was continued along the south side and over the point of the separating ridge and then dropped into pond B. It is the intention to pass this water from pond B into the spawning race at the head of the main pond. In preparation for the coming spawning season, a raceway of planks, 6 feet 2 inches wide and extending 110 feet into the main pond, was provided for conducting water from pond A, a temporary diverting dike having been erected on the natural outlet to throw the water through the raceway. Twelve-inch drain tiling was laid from the kettle of pond A to York Pond, and 350 feet of cast-iron pipe, leading from the main lake to the hatchery, was installed. Races Nos. 1 and 2 were put in shape for rearing operations; the sidetrack grade, running up Cold Brook, was cleared and work started on a third rearing race, which, like all the others, will have spring water rising copiously in it, augmented by water from race No. 1, independent springs, and wells, and water diverted from Cold Brook. Below this race there is opportunity for the construction of a number of ponds, the flow from which will be to the hatchery flat, where there is space for further pond construction. A fourth raceway has been started along the hillside west of the hatchery flat, and this will later be extended some distance west of Cold Brook.

During the summer months fishermen were employed to catch trout in the closed brooks. These streams are so filled with driftwood and brush that no other practicable method has yet been devised for taking them, and it was found that by filing off the barbs of rather large hooks the fish are not apt to undergo material injury. Of 1,964 captured in this manner only 12 had been lost at the end of the season. The fish were held in a large inclosure prepared for them on the natural inlet and fed until spawning time, when an examination disclosed that only 254 were mature females. These fish were so small that only 42,450 eggs were secured, and to supplement the supply 100,000 brook-trout eggs and 25,000 lake-trout eggs were forwarded from the St. Johnsbury station.

It having become evident that the cement hatchery and pipe line from York Pond could not be completed in time to care for the eggs,

a tent hatchery was installed on the run that is being converted into rearing race No. 3, and here the eggs were successfully held until the hatchery could be made ready to receive them.

The hatchery water-supply proved well adapted to trout incubation except that it contained large quantities of brown and green algæ, which gave serious trouble even though the eggs were mostly in an advanced stage when removed to the hatchery. After some losses and some experimenting it was discovered that the bad effects of the algæ might be overcome by placing the eggs, when just about to hatch, in the normal salt solution. Contact with the algæ appeared to toughen the shell so that the fish could not entirely emerge from it and the effect of the solution was to counteract the difficulty and restore the shell to its normal condition.

With the exception of 5,000 eggs planted in gravel in small brooks on the reservation no distributions of stock were made. All fish hatched were removed as sac-absorbed fry to the races, where they readily adapted themselves to their environment and began feeding readily. In addition to the fish hatched at the substation 77,000 brook trout and approximately 11,000 landlocked salmon were transferred from the St. Johnsbury hatchery.

NASHUA (N. H.) STATION.

[Waldo F. Hubbard, Superintendent.]

The year's output from this station consisted of 675,000 fingerling fish divided as to species among the brook trout, rainbow trout, lake trout, and landlocked salmon; also 83,700 fry of the pike perch and smallmouth black bass. As in past years, most of these fish were the product of eggs forwarded to Nashua from other sources, the only brood fish maintained at the station being a few each of the brook trout and rainbow trout, which yielded 127,950 and 83,550 eggs, respectively. This stock was augmented during the winter by the purchase of 795,000 brook-trout eggs from a commercial fish culturist and the transfer of 50,000 rainbow eggs from the White Sulphur Springs (W. Va.) station. Heavy losses of both species were sustained in the egg and fry stages, greatly curtailing the distributions. Other transfers of eggs included 46,000 of the lake trout taken in connection with the field work of the St. Johnsbury (Vt.) station, 21,000 landlocked-salmon eggs shipped from the Craig Brook (Me.) station, and 1,500,000 eyed pike-perch eggs from Put in Bay, Ohio. Owing to a protracted delay in delivery the latter consignment was received in poor condition and yielded only 75,000 fry. The salmon eggs were successfully hatched and most of the resulting fingerlings were being held for later distribution at the close of the year.

An attempt during the first half of June to collect smallmouth black-bass fry from Lake Sunapee, N. H., for supplying applicants in that region was almost a failure, only 8,700 being secured. The outcome of such work in the Lake Sunapee field is very largely dependent upon weather conditions. If it is windy, as it is very likely to be, great difficulty is experienced in locating the nests and collecting the fry. Much trouble has also been encountered in holding the collections of fry even for the period of a day without incurring large losses.

In order to remedy a defect in the original planning of the pond system and to provide for a more economical consumption of water, a part of the year's fish-cultural allotment was diverted to the removal of the earth partitions at the ends of the ponds and rearranging the system so that the water supply will flow through the entire series of ponds instead of through only two, as under the former arrangement. It is planned to have this work completed in time for the beginning of fish-cultural work next season.

The conduct of fish-cultural work at the Nashua station is annually becoming more difficult and uncertain. Shortage in the station's allotment of funds for a long period of years has prohibited all possibility of necessary repairs and improvements, with the result that the hatchery, ponds, water-supply flume, and other equipment have now reached such an advanced stage of dilapidation that it is not considered entirely safe to attempt the handling of a valuable brood stock of eggs or fish. It is estimated that a special fund of at least $20,000 would be required to place the station in condition for the conduct of fish-cultural work on an efficient and economical basis.

COMBINATION TROUT AND POND STATIONS.

The stations included in this group are located in the States of Tennessee, Iowa, Missouri, and West Virginia. As compared with last year's production their output of brook trout and rainbow trout was substantially increased, but the unseasonably cold, late spring resulted in a serious reduction in the distributions of the pond fishes. Some of these stations also incubated yellow-perch eggs and used the product for the stocking of local waters.

ERWIN (TENN.) STATION.

[A. G. KEESECKER, Superintendent.]

Though eight species of food fishes figure in the output at this point the principal part of the station's production consisted, as in past years, of fry and fingerling rainbow and brook trout, the former species predominating in numbers. Other fishes included in the distributions were largemouth black bass, smallmouth black bass, yellow perch, rock bass, and bluegill bream.

During the period from October 26 to the end of the first week in February 1,309,000 rainbow-trout eggs were taken from the station brood stock, but owing, it is believed, to the abnormally mild weather prevailing prior to and throughout the spawning season their quality was impaired to the extent that the losses to the eyed stage amounted to fully 44 per cent of the original stock. From the 743,740 fry hatched 659,770 fingerling fish were reared and distributed. As the natural conditions at this station are unsuitable for the maintenance of a brood stock of brook trout, all work accomplished with that species must necessarily depend upon the transfer of eggs from other sources. A stock of 285,700 eggs purchased from a commercial brook-trout hatchery was incubated with a loss of only 2½ per cent, and from the resulting fry 278,200 fingerlings Nos. 1 to 2½ were reared and distributed.

The spawning of the largemouth and smallmouth black bass began about April 20 and extended well into June. Twenty-seven nests of the former species yielded 55,135 young bass, of which 15,635 were fingerlings No. 1, while the distributions of the smallmouth bass included 7,450 fingerling fish. An adverse feature of this work was the loss of a material number of adult fish of both species during the breeding season, greatly reducing the output. The most careful observation failed to reveal the cause of the mortality. So far as could be determined there were no unusual environmental conditions, and the dead fish appearing on the surface of the ponds had apparently not suffered from disease and bore no discernible evidence of bruises or injuries of any kind. The 500,000 yellow-perch fry entering into the year's distributions were derived from a consignment of 1,000,000 eggs supplied from the shad station on the Potomac River.

A number of items of construction work were accomplished during the year, among the most important being the enlargement and deepening of two of the ponds and the construction and installation of a 400-foot concrete flume to replace the old decayed wooden conduit for supplying the pond system on the lower level of the station reservation. The hatching capacity of the station was increased by the construction of a shed building, 40 by 42 feet in dimensions on an 18-inch concrete foundation wall and concrete flooring, to house a supplementary series of troughs. Eighteen additional troughs of galvanized iron were purchased and will be set up in this building as soon as the necessary pipe connections can be made.

MANCHESTER (IOWA) STATION.

[F. E. Hare, Superintendent.]

In the latter part of July, 1922, this station was subjected to a heavy downpour of rain, which flooded the reservation within an incredibly short space of time, transforming the entire pond system into one large lake and permitting the escape of a large percentage of the fish held therein, among them being many of the adult trout that were being counted on as a source of egg supply. One of the direct consequences of this loss was the reduction in the output of rainbow trout to less than one-half that of the preceding year, though the prospects up to the time of this occurrence had promised an increased egg production both of the rainbow and the brook trout. Moreover the quality of the eggs secured from the surviving rainbows was so inferior that only 98,685 fingerling fish were produced and distributed from the 354,700 collected. The greater part of the losses among this stock occurred before the hatching period. With the view of replacing the losses of brood fish, selected lots of young trout of both species are being reared, among them being 8,200 of the finest brook-trout fingerlings and the entire lot of fry produced from a consignment of wild rainbow eggs, the latter having been received during the spring from one of the western stations of the bureau.

The egg collections from the adult brook trout, amounting to 133,000, were supplemented by the purchase of 358,000 eggs from commercial trout establishments and the transfer of 235,000 eggs

from stock collected for the Springville (Utah) hatchery. From this combined stock 649,250 fry were hatched, nearly 89½ per cent of the eggs handled, and the output for the year consisted of 445,545 fingerlings Nos. 1 and 2 with 30,400 still on hand at the end of the year.

Owing apparently to some peculiarity of the water supply, a disease of the gills has long been persistent among the brook trout held at this station and the many attempts to eradicate it have not thus far afforded much relief. In continuation of past efforts along this line a system of long narrow ponds with earth bottoms was recently constructed and provided with a good flow of water, plant growth, and other conditions in simulation of nature so far as might be possible. While the environment thus provided has not proved particularly effective in overcoming gill disease, it has been found that the ponds are much better adapted to the work of trout rearing than are the old rearing ponds on the reservation.

In addition to trout culture, operations were conducted with the smallmouth and largemouth black bass and the rock bass, though, with the exception of a few thousand fingerlings of the latter, no fish of these species were distributed. Judging from the large numbers of fry observed in the ponds the results of the nesting season of the black basses were successful, but the actual outcome of the season at the close of the year was uncertain, the ponds not having been drawn down at that time.

The nesting of the rock bass did not meet with a large measure of success. The actual number of young fish of this species on hand at the end of June could not be determined, but it is doubted if the yield of fingerlings will justify the time and labor expended in their production. It is believed the brood fish have almost outlived their usefulness and steps will be taken to replace them with younger fish in advance of the next spawning period.

Owing to the necessity of conducting all operations on a reduced allotment no construction work other than minor repairs and improvements could be undertaken. However, in recognition of the importance of protecting the station against a recurrence of last year's disastrous flood preparations were in progress toward the end of June for the erection of a cement dike to run parallel to the streams running through the eastern end of the reservation, the actual work of construction to be undertaken in July. As planned, this barrier will extend approximately 2½ feet above the level of the ground and from 12 to 18 inches beneath the surface. It will be 7 inches in thickness, with a terraced embankment, to be filled in on the side nearest the hatchery.

NEOSHO (MO.) STATION AND SUBSTATIONS.

[FRED J. FOSTER, Superintendent.]

The scope of the work at this station was considerably enlarged during the year by extending its activities into new fields—in one case by the lease of property suitable for pond-fish culture, and in others by effecting agreements for the conduct of trout-cultural operations on a cooperative basis with private fish-culturists. One of the results of such extension has been the establishment during

the year of a record collection of trout eggs, the total in round numbers amounting to 2,056,000, or 21½ per cent more than in any previous year in the station's history.

At the Neosho station 848,000 rainbow-trout eggs were collected between November 16 and February 19. This stock was materially reduced by losses, both in the egg stage and subsequently, and from it 181,965 fingerlings Nos. 2 and 3 were realized for distribution, with about 10,000 remaining on hand at the end of June.

It having been found that the best eggs at this station are the product of very young fish, a systematic policy of selective breeding and liberal feeding, with the object of increasing the percentage of early spawners, has been in progress for some time. The efforts in this direction are apparently bearing fruit, as the proportion of spawning trout under 2 years of age is steadily increasing, being now about double what it was before the experiments were instituted.

A slight deviation from past methods was made in the feeding of fry and small fingerlings. For the purpose of varying the diet the fish were given clabbered milk twice a day and beef heart three times a day. They took the milk readily and seemed to thrive equally as well as when fed exclusively on heart.

No definite cause could be assigned for a slight loss occurring in each lot of rainbow trout as they attained a length of 1¼ inches. A few of the fish showed what appeared to be an extremely minute threadworm in the intestines, but at 375 diameters these were hardly distinguishable. By immediately cutting off all food for a period of 24 hours and then giving nothing but clabbered milk for the succeeding four days the loss was reduced to normal proportions.

Late in April a more serious epidemic broke out in the troughs containing rainbow trout 2 or more inches in length, the more prominent symptoms being distortion of the head, faded-appearing gills, and an abnormally dark color, the latter being most pronounced among badly affected individuals. The kidneys showed disintegration with crystals. A careful examination by the bureau's pathologist failed to disclose the cause of the disease, but it is believed it may have been due to the presence of mineral substances in the water supply. There was no evidence of it among fish that had been removed from the hatchery to rearing ponds as fingerlings No. 1½, and thinning out of the young fish and early removal from the hatchery to rearing pools will hereafter be resorted to in the hope that a recurrence of the trouble may be averted.

The disease gyrodactylus developed in one pool of No. 2½ fingerling trout early in May, but was quickly dissipated by immersing the fish for a fraction of a minute in a 1:15 solution of pure cider vinegar. Ichthyophthirius made its appearance in one pond, but loss from this cause was prevented by immediately transferring the affected fish to another pond where they could be held in a good flow of running water.

Excellent results were attained in the hatching of a lot of 50,000 eggs from wild rainbow trout received on June 10 from the Bozeman (Mont.) station. The product of these eggs will be reared and reserved for a brood stock at Neosho and auxiliary stations.

The result of the season's work in the propagation of pond fishes at Neosho station was the poorest experienced in many years. This is attributed largely to adverse climatic conditions. An almost

steady downpour of rain during May and early June, when the distributions usually occur, roiled the pond water to such an extent as to make the collection of fry impossible, and by the time the water had begun to clear the schools of fish had broken up and become dispersed among the dense vegetation in the ponds. Under such conditions it became necessary to carry over the entire crop for distribution as fingerlings in the fall.

An investigation conducted in May by the bureau's pathologist disclosed the prevalence of a parasitic affection among the pond fishes. The tapeworm (*Proteocephalus ambloplitis*) was found in the sunfish and in both species of black bass, the larval stage of this parasite heavily infesting the ovaries of some of the individuals examined. This trouble is believed to be one of the main causes for the poor success heretofore attained in the pond fish-cultural work at this station. So little is known of the nature of the organism, however, that prospects for its control do not seem bright, and in view of the circumstances it may be found advisable to discontinue the efforts to produce the two species of black bass and confine future activities in pond work to the propagation of the bluegill and green sunfish, which appear to be more resistant to the ravages of the parasite than any of the other species.

A consignment of 7,800,000 yellow-perch eggs was received late in March from the bureau's station at Bryans Point, Md. Of these eggs 3,680,000 were turned over to the Missouri State hatchery at Springfield, and from the remainder 3,500,000 fry were hatched and distributed to applicants for that species.

ROARING RIVER (MO.) SUBSTATION.

Work in this field, which is about 50 miles east of Neosho, was conducted on a share basis, the bureau receiving an equitable percentage of the eyed eggs obtained from the owner's stock of brood trout. The egg collections, made between November 27 and February 24, proved very disappointing, only 959,000, in round numbers, being obtained from a brood stock large enough to have produced at least twice that number. The small yield was attributed to underfeeding of the fish, and as this was a factor over which the bureau had no control, it was decided that the expense would not justify the results in future operations and the agreement was terminated at the end of the year.

BOURBON (MO.) SUBSTATION.

Bourbon is located in the eastern section of Missouri about 65 miles distant from St. Louis, and the property in which the bureau is interested belongs to the von Hoffman Press Association of that city. The cooperative arrangement entered into with this association stipulates that the bureau shall provide the services of a man to conduct fish-cultural work on the property, while the association will bear all expenses of construction and maintenance of the plant, including purchase of fish food and subsistence for the bureau's employees. The bureau is to receive at least two-thirds of all fingerling fish produced, with the understanding that they are to be liberated in Missouri waters.

The outcome of the first season's operations at this point was encouraging, nearly 250,000 eggs being taken from the 1,200 yearling fish comprising the brood stock. The fish had been well fed, and as regards both quality of eggs and number secured the results were far better than at Roaring River. The total cost of the work to the bureau was less than $115, and its share of the proceeds was 96,000 fingerling trout Nos. 2 and 2½, all of which were liberated in waters in the eastern section of the State. One of the most advantageous features of the work in this field is the saving effected in distribution cost, as the stocking of these waters with fish produced at Neosho station would necessarily involve heavy transportation expenses.

GREER SPRINGS (MO.) SUBSTATION.

This field station, also operated for the first time during the year, is located on land belonging to L. E. Dennig, of Oregon County, Mo., who desires the cooperation of the bureau in developing here a source of supply for rainbow-trout eggs. Apparently there is nothing to interfere with the success of this undertaking, as the flow of spring water is abundant, amounting to approximately 204,000,000 gallons per 24 hours, and the site appears to be well suited to fish culture in other respects.

Under the agreement effected with the owner the bureau is to supply not less than 50,000 rainbow-trout eggs annually, to be hatched and reared at his expense in pools which he has constructed, half the product in fingerling fish to be distributed locally and the other half to be at the disposal of the owner. Of the 70,000 fingerling fish resulting from 100,000 eggs developed at this point during the spring 30,000 were planted as fingerlings No. 1½ in Greer Springs Branch late in March. The remainder was held to the No. 2½ fingerling size and liberated early in June.

LANGDON (KANS.) SUBSTATION.

At this place, about 35 miles east of Hutchinson, Kans., the bureau recently leased from Eugene Catte a pond system approximately 6½ acres in area which had been successfully employed by him in past years in the production of black bass, bream, and crappie. These ponds having recently been used for goldfish culture, no brood fish of the various species desired were available, hence collections had to be made from wild fish and transfers arranged for from other stations of the bureau. By the 1st of April a brood stock consisting of 366 black bass, 391 sunfish, 425 crappie, and 58 rock bass had been assembled and installed in the ponds. Nesting and rearing activities progressed favorably to the close of the year, though some of the stock was lost during a heavy rain that flooded the pond early in June, washing away considerable numbers of fry and fingerlings. Owing to shortage of funds no distributions could be made from these ponds prior to the close of the fiscal year.

There are 13 other ponds belonging to farmers in the vicinity of Langdon, and with these men an agreement has been effected whereby the bureau is to collect at stated intervals the fish they are able to produce in their ponds, paying for them at a stipulated price per thousand.

WHITE SULPHUR SPRINGS (W. VA.) STATION.

[EDWARD M. HAYNES, Superintendent.]

The outcome of the year's fish-cultural work was the most successful ever experienced in this field, the distribution of eyed trout eggs being the largest in the station's history while the production of fish compared favorably with the record output established in 1922. In fact, the volume of the work has now reached a point where it can not be further extended without enlarging the hatching and rearing facilities of the station. The results secured were accomplished in the face of unusually difficult conditions. Lack of rain throughout the entire fall reduced the water supply in the hatchery and ponds to such an extent that a considerable number of the brood trout perished though every possible precaution was taken to save them. While this loss did not appear to reflect unfavorably on the egg collections, its full force will be felt in a considerable curtailment of the work next year because of the shortage of brood fish. The year's operations were also unfavorably affected by adverse weather conditions during the spawning season of the so-called pond fishes. Sudden and extreme temperature changes of air and water occurred repeatedly throughout the entire spring, causing the parent fish to desert their nests and resulting in heavy losses of eggs and fry.

The species handled were the rainbow trout, brook trout, largemouth and smallmouth black bass, sunfish, and rock bass, and the grand total of the distributions aggregated 2,653,826, of which number 1,097,500 were eyed eggs of the rainbow trout. With the exception of 114,500 black bass, which were distributed in the fry stage, all the remainder of the output consisted of fingerling fish of the various species mentioned, rainbow and brook trout predominating.

Notwithstanding the injurious effect of the abnormally low water stages upon the brood rainbows, some of which succumbed prior to the spawning period and others immediately after being stripped, the egg collections, amounting to 2,316,000, were the largest in the station's history. Their quality was also good, the percentage of hatch exceeding that of the previous year, while the reports on eyed eggs shipped to applicants were uniformly favorable. The output of fingerlings from this stock numbered 726,900. The fish were distributed somewhat earlier than in former years and to this fact is attributed the smaller losses sustained in shipment. The health of young trout is liable to become somewhat impaired when they are held for an extended length of time under the crowded conditions necessitated by the limited rearing facilities available at this station, and for this reason the practice of early distributions should be continued, the work to be started not later than the middle of March if possible.

All brook-trout eggs handled were purchased from commercial fish-culturists, no collections being made or transfers effected from other hatcheries of the bureau. The number received amounted to approximately 923,000, nearly half of them being paid for by the State of West Virginia with the understanding that the product

hatched from an equal number of rainbow-trout eggs would be turned over to the State for distribution. Though the percentage of hatch was in excess of 96, the quality of the eggs as a whole was somewhat inferior and the losses of fry prior to the feeding stage were unusually heavy, especially on one lot that was badly affected by the disease known as "bluesac." The fish were distributed as fingerlings Nos. 1 and 2, the output amounting to 710,066 not counting 2,000 that were retained for future use as brood fish.

The output of black bass of both species amounted in round numbers to 117,000, or about 16,000 more than were distributed last year. Most of these were shipped in the advanced fry stage.

WYTHEVILLE (VA.) STATION.

[CHAS. B. GRATER, Superintendent.]

The output of this station amounted in round numbers to 695,000 eggs and fingerling fish, an increase of 63 per cent over the production of the previous year. About 25,000 of this number represented such pond fishes as the black bass, catfish, rock bass, and sunfish; 243,000 were eyed rainbow-trout eggs, and the remainder consisted of fingerling rainbow and brook trout.

On the stock of 1,044,000 eggs of the rainbow trout secured during the fall there was a loss of 347,500 owing to the presence of large numbers of defective eggs, known as "pinheads." Some of this heavy mortality was doubtless due to the advanced age of many of the brood fish, but it may also be attributed in large part to the poor physical condition of the brood stock as a whole, brought about by an insufficient water supply during the late summer and early fall when the flow from the spring was at a low ebb.

For the purpose of ascertaining the percentage of hatch a lot of eyed eggs was planted in a mixture of sand and gravel in one of the ponds. There were no results, but in another lot of the same age placed in nests of screened coarse crushed rock in a trough in the hatchery the mortality appeared to be very small, the fry emerging from the stones with the sac well absorbed within a period of two weeks.

At the beginning of the feeding stage two lots of fingerlings, equal as to numbers, size, and weight, were selected for the conduct of an experiment made to test the value of a commercial fish food composed of fish and cereal as compared with beef heart, the material in general use at this station for the feeding of fingerling fish. At the end of 60 days the lot that had been fed on beef heart showed an increased weight of 42.75 ounces as against a gain of 8.35 ounces for the fish receiving the commercial food. A second test was made with two equal lots of fingerlings that had been fed for a period of two weeks on beef heart. At the end of the 30 days' trial the lot that had been changed from the heart to the commercial brand of food showed a gain of only 12.75 ounces while the control lot had increased 24.75 ounces in weight.

Most of the adult fish at this station have been fed on liver and other slaughterhouse products in the past, but recently a change was made to beef heart mixed with varying proportions of mush. This diet has been found to result in a large production of eggs of good

quality, and it is believed it will do much toward the eradication of thyroid tumor, which appears to have gained a foothold among the brood stock. The presence of this disease is believed to be due in large measure also to the method employed in cleaning the ponds. Under certain conditions it is necessary to wash all accumulations of sediment down through a pond containing fish to the outlet at a time when the depth of the water does not exceed 8 to 10 inches. This is not considered conducive to the health of the fish, since a large amount of the waste matter must pass through their gills.

With the view of improving the methods in this respect a bulkhead extending about 6 inches below the surface of the water was recently installed about 12 feet below the upper end of one of the ponds, with a gateway in the center of it. When cleaning this pond the water in the upper section is lowered and that portion cleaned first, after which a seine is passed around the fish, causing them to enter the cleaned portion; the gate is then lowered, and the remainder of the pond cleaned without subjecting the fish to insanitary conditions.

Acting on a suggestion from the fish pathologist, a small quantity of iodine solution was mixed with the food given to one lot of fish in the hope that it might tend to lessen, if not prevent, the development of thyroid tumor. Sufficient time has not yet elapsed to permit of any statement as to its effect upon the fish.

The pathologist discovered that a large number of ailing No. 1½ fingerling trout were infested with flagellate. It has been noted that the mortality among fingerling trout of this size is considerably greater than among older fish, and also that it is heavier in the spring than at any other season of the year.

The filtering system was used during the incubation period and up to the time the fingerling fish were distributed. By the use of a dropping device for the purpose of introducing sulphate of alumina in the water-supply tank, in varying amounts to meet the requirements, the turbidity of the spring water was greatly reduced, most of the sediment being precipitated to the bottom of the tank. This greatly lessened the work of caring for the eggs and fry and it is believed to have averted a large loss of fry, especially of the brook trout, which do not appear to be able to survive roily water. Considerable trouble was caused by the development of "pop-eye" among one lot of rainbow trout that had been held in water taken direct from the spring, but on transferring them to troughs containing water supplied by the filter the disease lessened and gradually disappeared.

The efficiency of the station was greatly increased during the year by the installation of 18 newly constructed troughs in the old hatchery building and arranging them so that the water supply can be drawn either from the filter or direct from the spring. These troughs have a capacity for 1,000,000 trout eggs, 750,000 fry, or 180,000 fingerlings No. 1.

The new hatchery has two hatching rooms. The one in the basement is equipped with 20 troughs arranged in a single series on iron-pipe supports, each trough being 13 feet 5 inches long, 14 inches wide, and 6 inches deep. The room on the floor above contains 40 troughs arranged in two series, and the water supply, which may be taken either from the filter or direct from the spring, is

obtained from an open head trough. After passing through the first two troughs the water is carried into the waste ditch, and from there into the ponds containing the adult fish or directly into the creek, as may be desired. These two hatching rooms have a combined capacity for 3,540,000 eggs, 2,655,000 fry, or 590,000 fingerlings No. 1.

Early in the year arrangements were made for the thorough renovation of the bass ponds, which had become so filled with sediment and overrun with lilies as to have their usefulness greatly interfered with. A road scraper and team were employed so far as practicable to remove the sediment, which in many of the ponds was from 12 to 14 inches thick. In the ponds having soft bottoms it was found necessary to provide hard bottoms by first distributing a layer of coarse stones over the soil and filling the interstices with crushed rock.

Cement catch basins or kettles were installed in several of the ponds with the view of discontinuing the practice of drawing the small fish out into a screened box with the muddy water and then dipping them out with nets. This kettle, consisting of a cement basin about 5 feet wide and 12 to 14 feet long, with wide walls extending approximately 12 inches above the pond bottom, is set just ahead of the drain box. When the water has been lowered to a point level with the sides of the kettle all of it must then pass through the sluice gate cut into the side of the kettle next to the drain box. Following the water current, the little fish are naturally carried into the upper end of the kettle, where the water is comparatively clear.

POND FISH-CULTURAL STATIONS.

The output of the several stations composing this group was seriously curtailed by unfavorable weather conditions during the spawning season. Though unavoidable, this falling off is to be regretted as under the most favorable circumstances it has been found impossible to fully meet the demands for the so-called warm-water pond fishes, this applying especially to the two species of black bass. The aggregate output by species of these seven stations during the year was as follows:

Largemouth black bass	1,478,204
Smallmouth black bass	422,200
Sunfish	260,888
Crappie	6,980
Catfish	13,505
Rock bass	19,610
Warmouth bass	8,900

COLD SPRINGS (GA.) STATION AND SUBSTATIONS.

[CHARLES A. BULLOCH, Superintendent.]

The principal species produced at this station is the largemouth black bass and the pond space ordinarily devoted to the work is large enough to accommodate 800 brood fish. The persistent efforts made in advance of the spawning season to secure additional adult bass from various sources in Georgia and Florida to compensate for

the losses that have occurred recently were unsuccessful, and in the face of a shortage of nearly 200 breeders two of the ponds were allowed to remain idle. The bass work was still further curtailed by a total lack of results in two other ponds that had been stocked with adult bass transferred early in the spring from Washington, D. C. Notwithstanding these discouraging factors, however, the station's production of fry and fingerling fish of this species exceeded last year's by 140,000, while the total output of the station and its Harris Pond auxiliary was nearly two-thirds larger than that of the fiscal year 1922.

Early in the year the pathologist made an effort to discover the cause of the heavy mortality occuring among the adult bass. No conclusion was arrived at, but it is the belief of the station superintendent that it is due to some deficiency in the food supply. Chopped mullet constituted the food supply of these fish during the year, and while the losses have been lighter than last year when beef heart was being fed to them, the mortality has, nevertheless, been much heavier than at other stations where the hearts are generally employed as a food for brood fish.

The year's production of crappie was almost negligible, only 1,500 fingerling fish being realized from one half-acre pond. For some unknown reason this species has never responded satisfactorily to artificial propagation at the Bullochville station.

Past experience at this station has demonstrated that ponds containing water throughout the year or remaining dry for only two or three months during the year are apt to produce large numbers of such injurious insects as Dytiscus, Gyrinidæ, and Hydracarina. With this in mind it was decided to drain all ponds immediately after completing the distribution in the late summer of 1922 and allow them to remain empty until late in February. Apparently this change was very beneficial. Not only were undesirable insects unusually scarce during the spring, but the ponds contained more daphnids, cyclops, chirinomids, and other natural food for young fish than ever before.

As the water from Cold Spring has always been pronounced too deficient in lime for the best results in fish-cultural work, an experiment was started in September with the view of ascertaining if this defect might be overcome by introducing lime in the supply. In a box 4 feet square and 2 feet high a false slat bottom was inserted, 1 inch of space being left below the slats. This was placed in one of the ponds, a layer of coarse gravel distributed over the slats, a 2-inch layer of sand over that, and finally a barrel of freshly slaked lime. A three-fourths-inch pipe was then installed in such a way as to force water up from beneath the slats and cause it to flow evenly through the gravel, sand, and lime into the pond. On May 1 when the box was removed it was found that all the lime had dissolved. As the results attained in this pond during the succeeding spawning season were not distinguishable from those in the untreated ponds, it is evident that the experiment had no beneficial effect upon the water supply.

In the course of the year Cold Spring, the main source of the station water supply, was covered with a shingle roof supported on 8-foot studding set in concrete blocks. The exclusion of leaves and débris was accomplished by inclosing the studding with wire

poultry netting, and through the cutting off of the intense light to which the spring was subjected the growth of algæ will be largely prevented. In order to confine the water within the walls of the spring, which has always been difficult owing to the gravelly nature of the soil, a wooden bulkhead was set at a distance of 20 feet from the wall on the lower side and the intervening space filled in with red clay to a depth of 4 feet.

HARRIS PONDS (GA.) SUBSTATION.

Operations in this field extended from March 15 to the middle of October and consisted in the propagation of bluegill sunfish (bream) and catfish (*Ameiurus nebulosus*), the young fish being collected from the ponds in the Nos. 1 and 2 fingerling stages and transferred to Bullochville to be distributed with the fish shipped from that point. The outcome of the season's work was satisfactory, the production of sunfish exceeding that of any previous year, while sufficient numbers of catfish were distributed to fill all applications for that species. Fully 150 terrapin were captured in the ponds and destroyed during the season, and to this fact may be attributed a large measure of the success attained. However, a more serious menace to fish-cultural effort exists here in the form of numerous beetles of destructive species, and no successful method of combating it has yet been devised. The eggs of these beetles are deposited on the leaves of aquatic plants at or slightly above the surface of the ponds, where they are practically inaccessible. The supply of water from the springs is not sufficient to permit of changing levels during the spawning season, and the roiling of the water incident to wading into the ponds to cut the weeds would in all probability result in considerable losses through the smothering of the eggs.

At this field station the side ditches connected with the pond system were deepened and widened to exclude freshet waters and the shallow portions of several of the ponds were made deeper, the excavated material being utilized in the improvement of the division banks.

EDENTON (N. C.) STATION.

[W. S. VINCENT, Superintendent.]

In addition to the work concerned with the propagation of the anadromous fishes, mention of which may be found on page 54, the Edenton station produced the various pond fishes on a limited scale. Its output of such species during the year amounted to 62,920, of which the great majority were largemouth black bass fry and fingerlings. The remainder consisted of sunfish, catfish, and crappie, only negligible numbers of the two last named being produced.

LOUISVILLE (KY.) STATION AND SUBSTATION.

[CHARLES W. BURNHAM, Superintendent.]

Though pond fish-cultural activities at this station were concerned with four species of fish, the principal work, as in the past, consisted in the production of smallmouth black bass. Approximately 93 per

cent of the year's distributions were of this species, the remainder being largemouth bass, rock bass, and sunfish, each of which was produced in about the usual numbers. Adverse weather conditions during the first half of April interfered with the spawning season, and shortly after nesting had begun a sudden cold spell occurred, killing all eggs that had been deposited. Aside from this the season was a normal one and, as four ponds had been devoted to the smallmouth bass work instead of three as in past years, the final results were larger by 57,000 than in 1922, the previous record year. This extension of the work was made possible by the receipt of 150 adult bass just prior to the spawning season from collections made in the Lake Erie field.

Adult bass for the enlargement and improvement of the brood stock have been received annually from Lake Erie collections for several years, some arriving in the fall and other lots in the early spring. During the past three years these various lots of fish have been segregated and special observations made with the view of determining whether those acquired shortly before the breeding season might be expected to produce as good results as the others. While no definite conclusion has been reached, it is the opinion of the station superintendent that this question is not a factor of particular importance, and that, other things being equal, spawning may be expected to occur regardless of the exact time the fish are received.

During the months of July, August, and September an aquarial exhibit of various species of fish collected from the Ohio River was maintained and proved a great attraction to the large numbers of visitors at the station.

CAIRO (ILL.) SUBSTATION.

The work at this point consists in salvaging food fishes that have become stranded in the sloughs or pools formed by the periodical flooding of the Ohio River. Owing to high water stages in these sloughs the collections could not be undertaken during the early fall. The work was started on November 13 and between that time and December 2 fish to the number of 1,207,750 were removed from temporary waters and returned to the river channel, the predominating species being catfish, crappie, and sunfish, in the order named. The total cost of the operations amounted to $415, or an average of less than 35 cents per thousand fish handled.

MAMMOTH SPRING (ARK.) STATION.

[DELL BROWN, Superintendent.]

The work of repairing and improving the pond system, undertaken during the past fiscal year at this station, was extended well into the fall of 1922. Several unfinished pond banks were completed, a new levee was constructed to replace one that had been destroyed by muskrats, and 4-inch piping was purchased and installed to connect several of the ponds with the water supply. A sufficient amount of terra-cotta pipe for extending the supply to some of the unfinished ponds was also provided but not installed. During September and

October two abandoned ponds that had been allowed to grow up in weeds and bushes were cleared, and after plowing, harrowing, and leveling the soil, water was turned in and the bottoms thoroughly puddled by the use of a team and drag. The addition of these two ponds to the existing system will materially increase the pond fish-cultural facilities of the station. All buildings on the reservation, with the exception of the barn, were painted during the year, a number of minor repairs were made, and a considerable amount of grading and leveling was done on the grounds preparatory to sowing them to grass.

The corn received as rental for the use of a portion of the station reservation, together with the hay grown on the grounds and harvested by the station force, sufficed as feed for the station team practically throughout the year.

In view of the preparations made in advance of the spawning season for improving and enlarging the brood stock of the largemouth and smallmouth black bass, the results of the season's work were disappointing, the combined production of both species being but little in excess of 100,000 fingerlings. During the preceding fall and winter constant efforts had been put forth to acquire, by purchase and also by collections from open waters, all available adult bass not under 14 inches in length, and on April 15, when the collections ceased, the brood stock had been increased by the addition of 213 fish, giving a total of 500, of which 300 were largemouth bass. These fish had received as a regular diet throughout the fall and winter all the beef heart they would eat, in addition to about 50,000 common minnows obtained from neighboring streams. When apportioned among the breeding ponds their condition was most excellent.

The nesting of both species of black bass began on April 4 in a water temperature of 58°, and eggs were deposited freely throughout the spawning period in the four ponds devoted to the work. The spawning season of the smallmouth bass was completed by May 2, but eggs were deposited by the largemouth species up to and including June 10. The small results of the season's efforts were due to various adverse climatic conditions, among them being the cold, backward spring, sudden fluctuations in air and water temperatures, high winds, heavy rains, and muddy water. Suffocation of eggs and fry in the excessively muddy water experienced was probably responsible for the greater part of the loss sustained, taking the season as a whole, though starvation is believed to have been an important factor also, due to the inability of the fry to find sufficient natural food in the cloudy water. Moreover, it is reasonable to suppose that the natural food supply carried in the water during times of heavy rains and freshets is much smaller than when normal conditions obtain. The distribution of the smallmouth bass, consisting of 20,200 fingerlings Nos. 1 and 2, was completed in June, but collections of the largemouth species were still in progress when the year closed, the output up to that time amounting to 85,700 fingerlings. A compensating feature of the work was that all fish shipped were of fine quality, strong, and active.

From the single pond that had been devoted to the production of rock bass 17,600 fingerling fish were collected when the pond was lowered in October, 1922. The late fall distributions also included

14,000 sunfish (*Lepomis cyanellus*) and 400 crappie. The output of all of these fish was without doubt materially reduced through the ravages of a large number of pike, which were not discovered until the water was lowered to make the collections for distribution. These fish are believed to have gained access to the ponds through the supply pipe from the spring.

ORANGEBURG (S. C.) STATION.

[G. W. N. Brown, Superintendent.]

The output of fish from this station, amounting in round numbers to 435,000, represents the most successful year in its history. The great bulk of the production consisted of fry and fingerling largemouth black bass, the distributions of which were in excess of 400,000. Most of the remainder were sunfish, with a few fingerlings each of the warmouth bass and catfish.

The most serious obstacle encountered during the year was the flooding of a portion of the pond system by the heavy rains occurring in July, 1922, and the consequent loss of a considerable number of young fish. Other than this, natural conditions were in the main favorable to fish culture and a change in methods is believed to have been a material influence in producing good results. Instead of confining the brood bass in two or three ponds during the winter, as heretofore, involving a second handling in the spring, the fish were apportioned among the breeding ponds immediately after the conclusion of the annual cleaning of the ponds, and were allowed to remain undisturbed to the end of the spring spawning. During the winter they were given all the food they would take, and their condition at the beginning of the spawning period was much better than under the old system of frequent transfer and handling.

A catfish pond, 3 feet by 30 feet in dimensions, divided by screens into three compartments to permit of a free circulation throughout its length, was constructed and 1 pair of catfish placed in each compartment, it being the intention to follow up the experiment of hatching in troughs instituted recently at the Fairport (Iowa) biological station.

The overflow of the levees early in the year necessitated prompt action, the work involving the excavation of a deep ditch and the construction of a levee in order to divert the flood waters and save the pond system. The levees between the two reservoirs were then raised to a height sufficient to guard against a recurrence of damage during periods of excessive rain. Two spillways were constructed—one at the outlet of the main reservoir leading into the drain and one at the small upper reservoir. The recent erection of a steel-wire fence around the reservation has added greatly to the appearance of the station and will afford pasturage for the station horse.

An interesting experiment was made during the breeding season to test the possibilities of artificial propagation as applied to the black bass. On March 5 a nest of approximately 4,500 freshly laid eggs was carefully removed from one of the ponds and placed in a trough on a cheesecloth-covered tray. The eggs were found to run

3,000 to the liquid ounce, measuring 17 to the linear inch. On March 7 the eye spot was visible and by the 10th all live eggs had hatched, the number of fry being estimated at about 600. The heavy loss of eggs indicated was doubtless caused by injuries received when they were counted. On March 23 the young fish rose from the tray as sac-absorbed fry and were soon feeding eagerly on beef heart that had been prepared for them by running it through a meat chopper several times, rubbing through cheesecloth, and finally converting it into a thin soupy solution by the addition of water. On April 9, one month and four days after the removal of the eggs from the pond, they were distributed as advanced fry, their number being 394.

SAN MARCOS (TEX.) STATION.

[Mark Riley, Superintendent.]

There was a serious falling off in the production of fish at this station as compared with the work accomplished in 1922, the total distributions amounting in round numbers to 271,000, or considerably less than one-third of the record output established that year. The yield of the largemouth black bass, the most important species propagated, numbered 251,918, and 14,508 green sunfish (*Apomotis cyanellus*) were distributed. The other species handled during the year included crappie, rock bass, and warmouth bass, all of which were produced in negligible numbers.

The poor showing made in the year's fish-cultural work is attributed to excessive rains and severe cold prevailing prior to and during the early part of the spawning season. Weather conditions throughout the month of February were exceedingly unfavorable, and the sudden temperature changes experienced in March—the extreme range extending from 83° to 27°—proved very destructive to the nests of eggs. A determined effort was made to counteract these violent fluctuations of temperature by pumping into the ponds the warmer water of the San Marcos River, but it proved impossible to avert the disastrous losses of stock which occurred.

The station was compelled to cover the entire State, making many long trips that involved a much greater expenditure of funds than would have been necessary had the State fisheries authorities been able to cooperate as anticipated.

The inadequacy of the San Marcos station to meet the demands made upon it throughout the length and breadth of the State is every year becoming more apparent. Additional hatching centers are greatly needed. At the present time an undue proportion of the funds allotted for the work of the station is expended in shipping fish to applicants located at a great distance. Were it possible to eliminate the large expense annually incurred for transportation the funds thus saved would go a long way toward increasing the productiveness of the station.

In an effort to alleviate the situation the bureau has been negotiating with groups of interested citizens in different sections of Texas in an effort to secure financial cooperation in the construction of ponds where supplies of suitable fish may be raised to meet the

demands of the immediate region, the management of such field work to be under Federal supervision. With this object in view two ponds have been constructed at New Braunfels, Tex., and funds sufficient for the construction of a small hatchery plant at Medina Lake have been contributed. Several other communities have expressed a desire to cooperate in fish-cultural work, among them being Fort Worth, where an abundant supply of water of good quality is available.

It is a matter of regret that the clear-water ponds at San Marcos are not adapted to the culture of crappie, the popularity of which in Texas is only second to that of the black bass. In an effort to respond in some measure to the urgent requests for this species the bureau has for some time been introducing crappie in cattle tanks belonging to stockmen located in various parts of the State, with the understanding that a certain percentage of the young fish produced therein shall be available for its distributions. While some success has been attained along this line the scheme is not an entirely satisfactory one owing to the liability of many of the waters to disappear entirely during the long periods of drought to which they are occasionally subjected.

For a number of years past water for the station ponds has been supplied by the San Marcos Utilities Co. at an annual expenditure of $500. The service was not entirely satisfactory and at the suggestion of the company the agreement was terminated. A pumping outfit was then installed by the bureau with the view of providing its own water supply and the results of the change have demonstrated its advantages over the old plan. During the last six months of the year the cost of keeping the ponds filled with water has amounted to $150.90, showing a saving of practically $100 for the period. It is also possible under the present arrangement to obtain water at any time, whereas 24 hours' advance notice had to be given the company under the former plan.

TUPELO (MISS.) STATION AND SUBSTATION.

[David Davies, Superintendent.]

The Tupelo station produced a record output of fry and fingerling fish, the total amounting to 492,940, or more than 100,000 in excess of last year's output. This record was attained in spite of the heavy losses of eggs sustained late in March when a sudden cold spell and a drop of 17° in the water temperature caused many of the fish in the shallower portions of the ponds to desert their nests. All of the increase consisted in black bass, the production of both sunfish and crappie being somewhat smaller than in the previous year.

The new pond in course of construction during the past fiscal year was completed during the summer and fall and the pond was used for bass culture during the succeeding spring. This inclosure is of rectangular shape and covers an area of 2.14 acres. A considerable amount of repair work was done on the superintendent's residence and all buildings on the station were painted two coats of lead and oil paint, most of the work being done by the station force.

FRIAR POINT (MISS.) SUBSTATION.

On September 1 three employees of the Tupelo station with a temporary force of five men undertook the rescue of fish imprisoned in the shallow sloughs along the Mississippi River near Friar Point. Though unfavorable water stages delayed the operations fully 5 weeks beyond the usual time, and the work was hampered by inability to secure satisfactory auto-truck service, the number of fish secured during the season, which ended on November 23, was almost 100 per cent greater than in any previous year. The aggregate collections amounted to 1,644,239 miscellaneous fishes, the predominating species being sunfish, catfish, and buffalofish, in the order given. About 8 per cent of the collections were distributed to applicants and the remainder was returned to the main channel of the river.

CENTRAL STATION AND AQUARIUM, WASHINGTON, D. C.

[L. G. HARRON, Superintendent.]

Notwithstanding the limitations imposed upon the bureau's aquarial work in Washington, mention of which was made in the report of the division of fish culture for 1922, every possible effort was put forth to maintain as adequate a display of live fishes as the conditions would permit. So far as could be arranged for the methods of hatching employed at the different stations were illustrated, eggs for the purpose being forwarded to central station as they were available. The following eggs were received during the year:

Chinook salmon	15,000
Humpback salmon	49,125
Rainbow trout	24,515
Whitefish	1,152,000
Pike perch	1,000,000
Total	2,240,640

A large percentage of hatch was obtained on the salmon and trout eggs, and the resulting fry were healthy and vigorous until January 6, when a fresh supply of chlorine was introduced into the city water supply by the health authorities. Two days afterwards it was apparent that practically all fish and eggs on hand were affected, but the mortality among the rainbow-trout fry was so heavy that the lot had to be disposed of and the fry were liberated in the west branch of the Patuxent River. The chinook and humpback salmon seemed to withstand the effects of the chemical much better for a time, but on January 12 they also began dying rapidly and all fry of both species in stock were at once delivered to the Maryland Conservation Commission, at Baltimore, Md. Two thousand eggs of the chinook salmon were held with the view of trying to eliminate the gas from the water supply, but the experiment failed, all fry perishing soon after hatching.

The whitefish eggs, which were of excellent quality, seemed to withstand the presence of the chlorine for about 10 days. A small mortality then occurred and continued until late in February, when

it ceased, the eggs apparently having become immune. Of the 50,000 fry realized from this lot 3,000 were supplied to an applicant in New Jersey. The balance was held with the view of making observations as to their feeding habits, rate of growth, etc. The young fish eagerly took and appeared to thrive on a diet of pulverized beef heart, but in early May they began dropping off, the water temperature having become too warm. The last remnant of this lot survived until May 27, at which time they had attained a length of 1 inch.

A creditable display of adult fresh-water fishes was maintained during the early part of the fiscal year, but a few individuals included in a fresh lot of fishes brought in from outside sources were found to contain the parasite Ichthyophthirius. No heavy losses from this cause occurred during the winter, but with the rising of the water temperature in the spring the parasite multiplied rapidly and soon became so numerous that a large number of the fish were practically devoured by the ravages of the organism. Efforts directed toward the extermination of the affection through the application of strong limewater solutions were made and this work was progressing favorably at the close of the year.

Part 2.—DISTRIBUTION OF FISH AND FISH EGGS.

[E. C. Fearnow, Superintendent of Fish Distribution.]

BRIEF REVIEW OF THE WORK.

The output of the bureau's stations (see table, p. 9) for the fiscal year ending June 30, 1923 (4,314,859,029 fish and fish eggs), was distributed throughout the States and a consignment of eggs of the black-spotted and rainbow trouts was sent to the Territory of Hawaii. Shipments of fish eggs were also made to the Governments of Canada, Argentina, Czechoslovakia, Germany, and the Netherlands. Approximately 90 per cent of the net output consisted of fish and fish eggs of commercial species which, except in instances where the eggs were shipped to State fish commissions (see table, p. 96), were planted in waters where the egg collections were made. The species handled in this manner were shad, glut herring, whitefish, cisco, salmons, pike perch, yellow perch, striped bass, cod, pollock, and flounder. The principal species available for stocking interior waters are as follows: Black-spotted, brook, and rainbow trouts, catfish, largemouth black bass, smallmouth black bass, rock bass, crappie, and bream. While only one-tenth of the bureau's output is diverted to inland waters, the importance of maintaining a supply of food and game fishes in the waters of the interior States is attaining greater significance with the increased cost of food and the desire of some 7,000,000 of the population for the wholesome recreation of fishing. The importance of this phase of the bureau's work is recognized by the leading railroad companies, which, in many instances, furnish transportation at a reduced rate for the movement of the bureau's distribution cars, and grant special courtesies to distribution employees carrying living fish in baggage cars.

Valuable aid is received from State fisheries authorities, fish and game associations, and public-spirited individuals who arrange for the transportation of the fish from the railroad stations to the waters where they are to be planted. A wholesome effect of such cooperation has been the development of a sentiment against the destructive methods of fishing common in some localities.

SUMMARIES OF DISTRIBUTION.

DISTRIBUTION TO ALL APPLICANTS.

The following table shows in summarized form the numbers and species of fish and fish eggs of the net output of the hatcheries for the fiscal year 1923 that were delivered to applicants:

Summary, by species, of distribution of fish and eggs to all applicants, fiscal year 1923.

[Asterisk (*) denotes eggs; all others are fry, fingerlings, or yearlings.]

UNITED STATES AND TERRITORIES.

State and species.	Number.
Alabama:	
Catfish	8,000
Buffalofish	20
Crappie	1,255
Largemouth black bass	426,400
Rock bass	550
Sunfish	94,800
Alaska:	
Humpback salmon	240,000
Sockeye salmon	71,444,936
Brook trout	*50,000
Arizona:	
Catfish	3,600
Rainbow trout	*5,000
Black-spotted trout	24,000
Brook trout	70,000
Largemouth black bass	1,165
Sunfish	210
Arkansas:	
Rainbow trout	16,800
Crappie	400
Largemouth black bass	60,700
Smallmouth black bass	3,200
Rock bass	19,075
Sunfish	18,525
Yellow perch	400,270
California:	
Chinook salmon	3,804,400
Silver salmon	*100,000
Black-spotted trout	*100,000
Lake trout	*100,000
Colorado:	
Catfish	3,750
Steelhead salmon	50,000
Rainbow trout	*25,000 64,000
Black-spotted trout	385,000
Loch Leven trout	12,150
Lake trout	*50,000 120,000
Brook trout	3,361,050
Crappie	1,400
Largemouth black bass	10,250
Rock bass	1,000
Sunfish	475
Yellow perch	900
Connecticut:	
Rainbow trout	10,500
Lake trout	*60,000
Brook trout	117,975
Smallmouth black bass	600
Pike perch	130,000
Yellow perch	105
Delaware:	
Largemouth black bass	3,731
Sunfish	5,355
Yellow perch	500,000
District of Columbia:	
Steelhead salmon	150
Largemouth black bass	75
Florida:	
Largemouth black bass	2,000
Georgia:	
Catfish	5,950
Rainbow trout	54,600
Brook trout	36,000
Crappie	645
Largemouth black bass	151,940
Rock bass	50
Sunfish	52,900
Idaho:	
Catfish	1,500
Whitefish	*1,000,000
Chinook salmon	1,100,700
Rainbow trout	190,000
Landlocked salmon	20,349
Black-spotted trout	*175,000 31,500
Brook trout	98,700
Illinois:	
Catfish	929,320
Carp	*3,000,000 347,910
Buffalofish	*22,230,000 157,975
Rainbow trout	485
Brook trout	545
Pike and pickerel	16,690
Fresh-water drum	222
Crappie	387,993
Largemouth black bass	8,390
Rock bass	100
Sunfish	739,530
Yellow perch	4,605
White bass	777
Miscellaneous fishes	886,795
Indiana:	
Catfish	7,380
Brook trout	66,000
Crappie	620
Largemouth black bass	22,155
Sunfish	9,020
Yellow perch	1,260
Iowa:	
Catfish	10,188,038

Summary, by species, of distribution of fish and eggs to all applicants, fiscal year 1923—Continued.

UNITED STATES AND TERRITORIES—Continued.

State and species.	Number.
Iowa—Continued.	
Carp	*18,000,000
	8,152,470
Buffalofish	*12,825,000
	6,108,685
Rainbow trout	*155,600
	1,000
Lake trout	*75,000
Brook trout	5,875
Pike and pickerel	92,120
Fresh-water drum	16,294
Crappie	10,305,946
Largemouth black bass	68,854
Rock bass	750
Warmouth bass	80
Sunfish	5,695,870
Yellow perch	49,615
White bass	3,481
Miscellaneous fishes	8,174,647
Kansas:	
Catfish	600
Largemouth black bass	2,905
Sunfish	570
Kentucky:	
Catfish	755,600
Buffalofish	22,600
Crappie	307,125
Largemouth black bass	3,950
Smallmouth black bass	397,331
Rock bass	1,750
Sunfish	146,000
Louisiana:	
Catfish	2,278
Buffalofish	*128,114,500
	5,952,300
Carp	1,015
Pike and pickerel	60
Crappie	15,450
Largemouth black bass	1,384
Sunfish	21,450
White bass	5,595
Fresh-water drum	12,225
Miscellaneous fishes	803,568
Maine:	
Atlantic salmon	491,038
Landlocked salmon	809,070
Lake trout	*50,000
Brook trout	913,900
Smelt	*16,280,000
	28,000,000
Smallmouth black bass	3,169
White perch	675
Flounder	866,800,000
Maryland:	
Catfish	750
Carp	100
Shad	9,837,500
Whitefish	*192,000
Chinook salmon	*15,000
	14,000
Humpback salmon	6,350
Rainbow trout	*115,000
	39,800
Brook trout	3,450
Crappie	700
Largemouth black bass	3,564
Rock bass	600
Sunfish	580
Yellow perch	63,957,200
Massachusetts:	
Rainbow trout	17,900
Lake trout	*200
Brook trout	*200
	243,156
Smallmouth black bass	9,000
Pike perch	355,000

State and species.	Number.
Massachusetts—Continued.	
Cod	*650,980,000
	376,813,000
Haddock	*104,400,000
	2,960,000
Pollock	*33,960,000
	276,098,000
Flounder	*229,345,000
	159,032,000
Michigan:	
Catfish	2,700
Carp	30
Whitefish	*17,440,000
	22,350,000
Cisco	*10,000,000
Steelhead salmon	40,000
Landlocked salmon	*15,825
	10,000
Rainbow trout	62,000
Lake trout	*1,928,000
	27,402,708
Brook trout	341,800
Crappie	2,625
Largemouth black bass	18,950
Smallmouth black bass	46,250
Sunfish	925
Pike perch	2,325,000
Yellow perch	300
Minnesota:	
Catfish	5,819,180
Buffalofish	24,593
Carp	1,008,865
Whitefish	1,025,000
Steelhead salmon	33,000
Rainbow trout	37,000
Lake trout	*200,000
	1,595,000
Pike and pickerel	311,710
Brook trout	142,300
Crappie	11,018,770
Largemouth black bass	99,095
Rock bass	1,010
Sunfish	7,818,560
Pike perch	850,000
Yellow perch	519,740
Fresh-water drum	18,950
White bass	20,580
Miscellaneous	534,900
Mississippi:	
Catfish	313,085
Buffalofish	88,480
Carp	300
Crappie	8,524
Largemouth black bass	146,831
Rock bass	1,545
Sunfish	653,900
White bass	2,650
Missouri:	
Catfish	1,350
Rainbow trout	*463,360
	115,290
Crappie	2,300
Largemouth black bass	41,378
Smallmouth black bass	17,038
Rock bass	3,240
Sunfish	13,171
Yellow perch	*3,680,000
	2,000,150
Montana:	
Whitefish	*1,000,000
Steelhead salmon	*100,000
	50,000
Rainbow trout	577,740
Black-spotted trout	*2,988,700
	522,200
Lake trout	50,000

Summary, by species, of distribution of fish and eggs to all applicants, fiscal year 1923—Continued.

UNITED STATES AND TERRITORIES—Continued.

State and species.	Number.
Montana—Continued.	
Brook trout	*375,000
	849,450
Largemouth black bass	500
Nebraska:	
Catfish	454
Brook trout	54,000
Largemouth black bass	800
Yellow perch	450
Nevada:	
Steelhead salmon	*100,000
Rainbow trout	18,000
New Hampshire:	
Chinook salmon	*120,000
Steelhead salmon	*50,000
Landlocked salmon	*20,349
Rainbow trout	37,200
Lake trout	*50,000
	52,500
Brook trout	659,764
Smallmouth black bass	400
Pike perch	75,000
New Jersey:	
Whitefish	3,000
Steelhead salmon	*25,000
Rainbow trout	*100,000
Brook trout	27,000
Largemouth black bass	1,475
Smallmouth black bass	2,000
Sunfish	396
Pike perch	750,000
New Mexico:	
Catfish	9,900
Carp	180
Rainbow trout	*69,500
Black-spotted trout	*50,000
	284,000
Brook trout	*300,000
	180,000
Crappie	210
Largemouth black bass	2,050
Sunfish	1,040
Yellow perch	500
New York:	
Catfish	4,075
Buffalofish	30
Whitefish	*34,009,000
	85,300,000
Cisco	39,000,000
Steelhead salmon	*50,000
Landlocked salmon	1,400
Rainbow trout	*25,000
	92,800
Black-spotted trout	*10,000
Lake trout	*1,260,000
	1,696,000
Brook trout	607,600
Crappie	1,770
Largemouth black bass	15,710
Smallmouth black bass	7,394
Rock bass	2,000
Sunfish	1,880
Pike perch	600,000
Yellow perch	801,115
North Carolina:	
Catfish	575
Glut herring	150,000,000
Steelhead salmon	450
Rainbow trout	494,020
Brook trout	216,900
Crappie	120
Largemouth black bass	189,682
Smallmouth black bass	2,800
Rock bass	11,675
Warmouth bass	2,225
Sunfish	23,340
Yellow perch	500,000
Striped bass	16,341,000

State and species.	Number.
North Dakota:	
Catfish	13,000
Buffalofish	1,110
Crappie	6,425
Largemouth black bass	1,800
Sunfish	1,965
Yellow perch	1,400
Ohio:	
Catfish	11,000
Carp	*8,000,000
	115,000,000
Whitefish	*22,400,000
	100,000,000
Steelhead salmon	*20,000
Rainbow trout	*60,000
Brook trout	18,000
Crappie	2,975
Largemouth black bass	8,150
Smallmouth black bass	4,475
Sunfish	3,650
Pike perch	*37,275,000
	51,100,000
Yellow perch	1,300,395
Oklahoma:	
Rainbow trout	119,000
Rock bass	200
Sunfish	1,860
Yellow perch	1,100,000
Oregon:	
Chinook salmon	*3,790,000
	6,038,500
Chum salmon	95,000
Silver salmon	2,633,600
Sockeye salmon	*5,045,000
Steelhead salmon	*410,000
	3,466,000
Rainbow trout	105,000
Black-spotted trout	*50,000
	27,500
Lake trout	25,000
Brook trout	25,600
Pennsylvania:	
Catfish	24,696
Buffalofish	50
Whitefish	*28,000,000
Rainbow trout	*831,000
	128,300
Brook trout	318,259
Crappie	2,354
Largemouth black bass	26,440
Smallmouth black bass	2,000
Rock bass	375
Sunfish	5,397
Pike perch	800,000
Yellow perch	1,201,920
Rhode Island:	
Flounder	32,949,000
South Carolina:	
Catfish	180
Rainbow trout	14,400
Brook trout	8,000
Largemouth black bass	227,864
Smallmouth black bass	1,900
Rock bass	274
Warmouth bass	5,975
Sunfish	17,410
South Dakota:	
Catfish	2,800
Rainbow trout	*310,440
	103,500
Loch Leven trout	25,650
Brook trout	593,400
Crappie	400
Largemouth black bass	7,650
Sunfish	570
Tennessee:	
Catfish	5,600

Summary, by species, of distribution of fish and eggs to all applicants, fiscal year 1923—Continued.

UNITED STATES AND TERRITORIES—Continued.

State and species.	Number.
Tennessee—Continued.	
Rainbow trout	*2,000
	86,110
Brook trout	18,800
Crappie	60
Largemouth black bass	48,133
Smallmouth black bass	2,750
Rock bass	5,400
Sunfish	10,275
Texas:	
Catfish	400
Rainbow trout	1,554
Crappie	4,300
Largemouth black bass	249,168
Rock bass	260
Warmouth bass	70
Sunfish	15,503
Utah:	
Catfish	28,400
Black-spotted trout	1,600
Rainbow trout	333,750
Lake trout	*150,000
Brook trout	270,400
Vermont:	
Steelhead salmon	*50,000
	8,300
Landlocked salmon	20,349
Rainbow trout	1,200
Lake trout	*130,100
	202,787
Brook trout	*100
	366,524
Smallmouth black bass	1,100
Virginia:	
Catfish	11,925
Carp	80
Shad	7,133,500
Rainbow trout	146,050
Brook trout	153,600
Crappie	225
Largemouth black bass	43,485
Smallmouth black bass	27,000
Rock bass	12,950
Sunfish	22,830
Yellow perch	64,568,750
Washington:	
Chinook salmon	*80,000
	18,727,445
Chum salmon	23,177,730
Humpback salmon	2,066,035

State and species.	Number.
Washington—Continued.	
Silver salmon	11,648,055
	*534,464
Sockeye salmon	16,185,400
	*442,000
Steelhead salmon	1,963,105
Rainbow trout	53,000
Black-spotted trout	*105,000
	158,600
Brook trout	7,600
West Virginia:	
Catfish	1,275
Rainbow trout	*1,000
	583,600
Brook trout	667,066
Largemouth black bass	68,880
Rock bass	1,230
Sunfish	680
Yellow perch	300
Wisconsin:	
Catfish	18,930,221
Buffalofish	2,998,995
Carp	4,715,160
Rainbow trout	126,400
Lake trout	*3,000,000
	3,886,500
Brook trout	625,000
Pike and pickerel	484,815
Crappie	13,529,930
Largemouth black bass	170,945
Sunfish	11,475,595
Pike perch	6,380,000
Yellow perch	351,870
White bass	7,002
Fresh-water drum	1,335
Miscellaneous fishes	5,418,232
Wyoming:	
Catfish	5,400
Steelhead salmon	*75,000
Rainbow trout	*309,000
	531,160
Black-spotted trout	*6,331,400
	2,218,400
Lock Leven trout	6,000
Lake trout	*150,000
Brook trout	250,945
Largemouth black bass	7,400
Sunfish	25
Yellow perch	450

FOREIGN COUNTRIES.

Country and species.	Number.
Argentina:	
Steelhead salmon	25,000
Canada:	
Black-spotted trout	317,000
Steelhead salmon	400,000
Whitefish	44,000,000
Czechoslovakia:	
Rainbow trout	100,000
Germany:	
Rainbow trout	68,000
Netherlands:	
Chinook salmon	200,000
Rainbow trout	50,000
Total	45,160,000

ASSIGNMENTS OF FISH AND FISH EGGS TO STATE AND TERRITORIAL FISH COMMISSIONS.

The following table gives the numbers and species of fish and fish eggs delivered to State and Territorial fish commissions as applicants:

Assignments of fish and fish eggs to State and Territorial fish commissions, fiscal year 1923.

[Asterisk (*) denotes eggs; dagger (†) fry; all others are fingerlings.]

State and species.	Number.
Alaska:	
Brook trout	*50,000
Sockeye salmon	*5,098,936
California:	
Black-spotted trout	*100,000
Lake trout	*100,000
Colorado: Lake trout	*50,000
Connecticut: Lake trout	*30,000
Hawaii:	
Black-spotted trout	*50,000
Rainbow trout	*25,000
Idaho:	
Black-spotted trout	*125,000
Brook trout	900
Catfish	1,500
Rainbow trout	4,500
Whitefish	*1,000,000
Iowa:	
Lake trout	*75,000
Rainbow trout	*153,600
Louisiana:	
Black bass	24
Buffalofish	†1,200,000
Crappie	250
Sunfish	1,700
Maine: Lake trout	*50,000
Maryland:	
Brook trout	750
Chinook salmon	*15,000
Do	†4,000
Crappie	100
Humpback salmon	†3,350
Rainbow trout	400
Do	*114,000
Whitefish	*192,000
Michigan:	
Cisco	*10,000,000
Lake trout	†636,000
Minnesota:	
Black bass	600
Catfish	12,700
Crappie	17,900
Lake trout	*200,000
Sunfish	7,520
Yellow perch	100
Missouri:	
Rainbow trout	*50,000
Yellow perch	*3,680,000
Montana:	
Black-spotted trout	*1,599,000
Lake trout	*50,000
Steelhead salmon	*100,000
Whitefish	*1,000,000
New Hampshire:	
Chinook salmon	*120,000
Lake trout	*50,000
Landlocked salmon	*20,349
New Jersey:	
Rainbow trout	*100,000
Sunfish	88
New Mexico:	
Black-spotted trout	*50,000
Do	62,000
Brook trout	*300,000
Rainbow trout	*69,500
New York:	
Lake trout	*1,250,000
Whitefish	*31,885,000
North Dakota:	
Black bass	400
Buffalofish	1,110
Catfish	9,600
Crappie	5,550
Sunfish	1,330
Yellow perch	1,100
Ohio: Pike perch	*37,275,000
Oklahoma: Rainbow trout	119,151
Oregon:	
Black-spotted trout	*50,000
Chinook salmon	*4,000,000
Sockeye salmon	*5,045,000
Steelhead salmon	*370,000
Pennsylvania:	
Rainbow trout	*681,000
Whitefish	*28,000,000
Utah:	
Catfish	28,400
Lake trout	*150,000
Vermont:	
Lake trout	*130,000
Landlocked salmon	*20,349
Steelhead salmon	8,000
Washington:	
Sockeye salmon	*534,464
Steelhead salmon	*95,000
Do	50,000
West Virginia:	
Brook trout	352,000
Rainbow trout	500,000
Wisconsin:	
Black bass	8,350
Catfish	16,150
Crappie	7,800
Lake trout	*3,000,000
Do	†1,760,000
Wyoming:	
Black-spotted trout	*550,000
Do	†300,000
Lake trout	*150,000
Rainbow trout	*309,000
Total	*138,112,198
	†3,903,350
	1,219,973

METHODS OF DISTRIBUTION.

Each species of fish spawns at a certain time during the year and the resultant fry and fingerling fish are distributed as soon thereafter as practicable. The product of each season is distributed as the fish attain proper size for shipment, and only brood stock is carried over from year to year.

Applications for fish are filled in the order of their receipt, and the number that can be supplied for a particular body of water depends on the supply of the species desired and the size of the fish at the time of shipment. Owing to the greater value of fingerling fish for stocking purposes it is unnecessary to furnish them in as large

numbers as fry. It is the policy in all cases to furnish a sufficient number of small fish to form a brood stock. The bureau refuses requests for black bass and allied predacious species for introduction into waters in California, Oregon, Idaho, Washington, Nevada, and western Wyoming, as their presence in such waters might prove harmful to the trout and salmon fisheries of that region.

Fish are delivered to the applicant's railroad station without expense to him. Formal applications to be properly executed should be indorsed by a United States Senator or Representative. Blanks on which application for fish may be made, together with full particulars concerning the bureau's method of distributing living fish, will be furnished upon request.

DISTRIBUTION OF FISHES OF INTERIOR WATERS.

CAR NO. 3.

[E. R. WIDMYER, Captain.]

On July 24, 1922, a carload of warm-water fishes was received from the La Crosse (Wis.) station and delivered to applicants in South Dakota, Nebraska, Wyoming, and Montana. On completing this trip the car proceeded to Bozeman, Mont., and took up the distribution of trout from the bureau's station at that place. After making 8 carload trips from Bozeman, the car was placed at the disposal of the Montana State Fish Commission for which it made 8 carload shipments. After completing the State work the car again returned to Bozeman, making a carload shipment of trout to Omaha, Nebr., from which point it proceeded to Dubuque, Iowa.

Owing to the fact that car No. 3 is of wooden construction, and that practically all main-line trains in Montana are of steel construction, the car was detached from trains frequently and left to lay over for from 12 to 18 hours at a time. However, all deliveries of fish were made in good condition, and from July 24 to October 29, the date on which it returned to Dubuque, Iowa, the car had made 9 trips for the bureau and 8 for the Montana Fish Commission, traveling 11,987 miles and delivering 2,981,650 fingerling fish.

In handling the Montana State distribution in conjunction with the Bozeman distribution great saving in transportaton can be brought about by cooperation of the Bozeman and State superintendents, and it is suggested that an advanced outline of their work for the season be furnished the captain in charge of the car.

In connection with the Montana distribution the Oregon Short Line was the only road that furnished free transportation for the bureau's car. The Chicago, Milwaukee & St. Paul Railway gave a 5-fare rate by special request only, all other roads charging 10 full fares.

The car was used in the distribution of warm-water fishes from October 29 until the close of the season, when it was placed in the Milwaukee shops for winter repairs.

The spring distribution of car No. 3 was begun on May 10, 1923, when a carload of trout was received from the La Crosse (Wis.) station and delivered to Wisconsin and Minnesota applicants. The car then proceeded to Duluth, Minn., where the distribution of trout

and whitefish was taken up from the Duluth station. From May 13 to June 20 the car and its messengers shipped from the Duluth station 2,625,000 whitefish fry, 11,495,000 lake-trout fry, 7,630,000 pike-perch fry, 90,000 steelhead-trout fry, and 135,000 brook-trout fry, a total of 21,975,000 fish. On June 21 the car left Duluth for Manchester, Iowa, from which station a carload of fingerling trout was obtained for delivery to Minnesota and Wisconsin applicants, the car returning to La Crosse.

While engaged in the Duluth distribution the Fearnow pails were given a thorough trial and found to be far superior to the 10-gallon round-shouldered cans for transporting fish, and the car's equipment is being changed to carry a complete set of pails.

During the fiscal year ended June 30, 1923, car No. 3 traveled 14,815 miles and delivered 24,956,650 fish.

CAR NO. 4.

[Fred W. A. Engelhardt, in charge.]

On July 18, 1922, the initial trip of the season was made from Dubuque, Iowa, to Marquette, Iowa, where the car received consignments of river fishes for distribution en route to Malta, Colo. A part of the load was delivered at Burnham, Colo., but the bulk of it was distributed to applicants at Denver. The car then proceeded to Malta, from which point shipments of trout were to be made, arriving there July 25. Owing to the fact that the black-spotted trouts were not sufficiently developed, the distribution of that species was delayed until August 14. In the meantime the crew was engaged in making messenger shipments of brook and rainbow trouts to various points in Colorado.

During August, 1922, car trips with brook and black-spotted trouts were made from Malta, Colo., to Trinidad, Colo., and to Albuquerque, N. Mex. In the latter part of the month a washout in the road between Florence and Pueblo, Colo., caused a delay of 24 hours in the car schedule. In September a car trip with brook and black-spotted trouts was made from Malta to Las Vegas, N. Mex. While en route, the Colorado Fuel & Iron Co., at Trinidad, Colo., was supplied with an " owner's share " of brook and black-spotted trouts. Messenger trips with trouts to various points in Colorado were also made during the month.

While en route from Malta to Dubuque, Iowa, the car was detached from an all-steel train. This happens occasionally and sometimes causes a delay of 24 hours or more. During October car trips with river fishes were made from Marquette, Iowa, to Kansas City, Mo., and Williamsport, Pa.

The car then returned to Washington, D. C., to remain during the winter. During part of the time, however, it was at the Wilmington (Del.) shops undergoing repairs. In June, 1923, the car proceeded from Washington to Northville, Mich., in order to take up the distribution from that point. While at Northville the car crew made messenger shipments to various points in Michigan, and also assisted the station crew in collecting fish, raking moss, and cleaning ponds. Car trips with smallmouth black bass and trout were made from

Northville to Detroit and to Auburn, N. Y., messenger shipments being made en route.

After finishing the Northville distribution the car was prepared to make a trip to La Crosse, Wis., in order to take up the distribution of river fishes during the fiscal year 1924. The car was furnished with 140 Fearnow aluminum pails with which to carry on future distributions.

During the fiscal year 1923 it was impossible to secure any free transportation. In July, 1922, the Burlington Route agreed to handle the car from Omaha, Nebr., to Denver, Colo., for five full fares. The Denver & Rio Grande Western Railroad refused free transportation, but agreed to handle the narrow-gauge baggage cars that are used to distribute carload lots between Alamosa, Colo., and Durango, Colo., for five full fares.

During the fiscal year 1923 car No. 4 traveled 9,362 miles and distributed 46,355 river fishes and 1,080,500 trout.

CAR NO. 7.

[E. M. Lamon, Captain.]

On July 20, 1922, the distribution from the La Crosse (Wis.) station was taken up. Approximately 45,000 fingerling pond fishes were distributed in Wisconsin, Minnesota, North Dakota, and South Dakota, by messenger shipments from La Crosse. From July 20 to October 27, 128,825 fingerling pond fishes were distributed to applicants in Wisconsin, Michigan, North Dakota, South Dakota, Missouri, Illinois, Ohio, Indiana, West Virginia, Maryland, and New York. The car left La Crosse on October 25 on its last trip for the season with a carload of miscellaneous fishes for applicants in the vicinity of Washington, D. C., the shipment including a number of specimens for central station. The car arrived in Washington on October 27, and after the distribution work was completed it was placed in the United States Navy Yard for general repairs, and the messengers were detailed to stations for the winter to assist in fish-cultural work.

On March 2, 1923, the car left Washington to take up the trout distribution from the Erwin (Tenn.) station. Between March 2 and April 15, when the Erwin work was completed, 245,000 fingerling brook trout and 465,700 fingerling rainbow trout were distributed in Tennessee, North Carolina, South Carolina, and Georgia. From Erwin the car proceeded to Wytheville, Va., making a trip from the Wytheville station to Pennsylvania with 52,200 fingerling brook trout and 16,000 fingerling rainbow trout, returning to White Sulphur Springs, W. Va., and taking up the trout distribution from that station. Between May 1 and June 15, 249,850 fingerling brook trout and 156,100 fingerling rainbow trout were distributed from the White Sulphur Springs station in West Virginia, Maryland, Pennsylvania, and New York.

The work at the White Sulphur Springs station could be greatly improved if cooperation could be effected with the Chesapeake & Ohio Railway Co. and the bureau's cars given the same service by it that they receive from other leading railroads of the country.

The Fearnow transportation pails have been very successfully used during the year and the car is now fully equipped with them. A trip was made from Manchester, Iowa, to Madison, Wis., just before the close of the fiscal year, and 200 of these pails were very successfully transported on one trip. It is found that by using these pails instead of the standard 10-gallon cans the carrying capacity of the car can be increased over 50 per cent, with no increase in weight.

During the fiscal year 173,825 fingerling pond fishes, 614,200 fingerling brook trout, and 1,267,400 fingerling rainbow trout were distributed by the car in 23 trips, 18,685 miles being traveled.

CAR NO. 8.

[E. K. BURNHAM, Captain.]

At the beginning of the fiscal year fisheries car No. 8 was engaged in the distribution of brook and rainbow trouts from the Duluth (Minn.) hatchery; the season closed with the completion of the salmon and trout distribution from the Craig Brook (Me.) hatchery.

While the car was undergoing general repairs at the Washington Navy Yard during the winter its interior was sufficiently rearranged to permit of the installation of a small dining room capable of accommodating four persons at the table. The dining room has eliminated the annoyances attendant upon the former practice of setting up a table for each meal at the center of the car, thus blocking the aisle.

By the adaptation of the fish compartment on one side of the car for carrying 100 aluminum fish pails, the capacity of the car has been increased from 140 cans to 170 cans of fish. At the close of the fiscal year the fish compartment on the other side of the car was changed by the car crew to make the total capacity of the car 216 aluminum fish pails. Nearly all minor repairs and many of the changes and improvements in the car are made by the regular car crew while distribution work is not in progress.

The most important improvement made to the car during the year was the installation of an electrically driven air pump. This pump furnishes 5 cubic feet of free air per minute and is operated by a one-half horsepower electric motor, the electricity being obtained from the storage batteries of the car's electric lighting system. An important saving is effected by using this electricity for pumping air for the fish, as during the last fiscal year the car used approximately 8 tons of anthracite coal to generate steam for pumping air.

During the fiscal year 1923 the car was engaged in the distribution of fish from nine of the Federal hatcheries. Fourteen species of food fishes were distributed to suitable waters in 19 States, the farthest west being Utah. During the year the car handled over 1,500,000 fingerling and yearling fish. During the course of the year the car traveled on 19 different railroads, the total miles traveled being 18,823. Nineteen and one-half tons of ice were used during the year for maintaining a suitable water temperature for the fish.

CAR NO. 9.

[A. H. KERTH, Captain.]

Car No. 9 made 17 trips during the fiscal year 1923, covering a total distance of 18,275 miles, and supplying 1,076 applicants in the Middle Western, Southwestern, Eastern, and Southeastern States. The numbers and species of fish delivered during the year are as follows:

	Number.
Catfish:	
Fingerlings	33,100
Yearlings	1,200
Buffalofish, fingerlings	150
Carp, fingerlings	230
Rainbow trout, fingerlings	84,000
Brook trout, fingerlings	528,600
Pike and pickerel, adults	160
Crappie:	
Fingerlings	625
Yearlings	1,135
Adults	54
Largemouth black bass:	
Fingerlings	52,195
Adults	160
Smallmouth black bass, fingerlings	8,775
Warmouth bass, fingerlings	80
Sunfish:	
Fingerlings	9,790
Yearlings	5,240
Pike perch, fry	2,100,000
Yellow perch, fingerlings	3,250
Crappie and bream, yearlings (carload shipment)	9,000
Miscellaneous, assorted sizes, specimens	740
Total	2,838,484

No extensive repairs have been made to car No. 9 during the past year; neither has it been equipped with the Fearnow aluminum transportation pails (for description see U. S. Bureau of Fisheries Doc. 941, pp. 90–98), but a number of these pails are to be forwarded in the near future.

A new style aerator for use by messengers when carrying fish on detached shipments has been furnished by the Washington office (see description, p. 102) and has proven very satisfactory.

An aerating device of the jetting design has also given quite satisfactory results.

The total number of miles traveled by the car during the fiscal year was 18,275.

NEW EQUIPMENT FOR USE IN SHIPPING LIVE FISH.

ELECTRIC AIR COMPRESSOR.

During the spring of 1923 there was installed on fisheries car No. 8 an air compressor operated by a one-half horsepower electrically driven motor, connected with the storage batteries used for lighting the car. The entire outfit is only 28 inches long, 18 inches wide, and 2 feet in height, and is placed on a shelf in the boiler room. This device has been used successfully on a number of occasions for furnishing compressed air for aeration of the water in the fish contain-

ers, and obviates the necessity of using the steam boiler for this purpose during the summer months, thereby effecting a considerable saving in the amount of coal used. The device has been used to

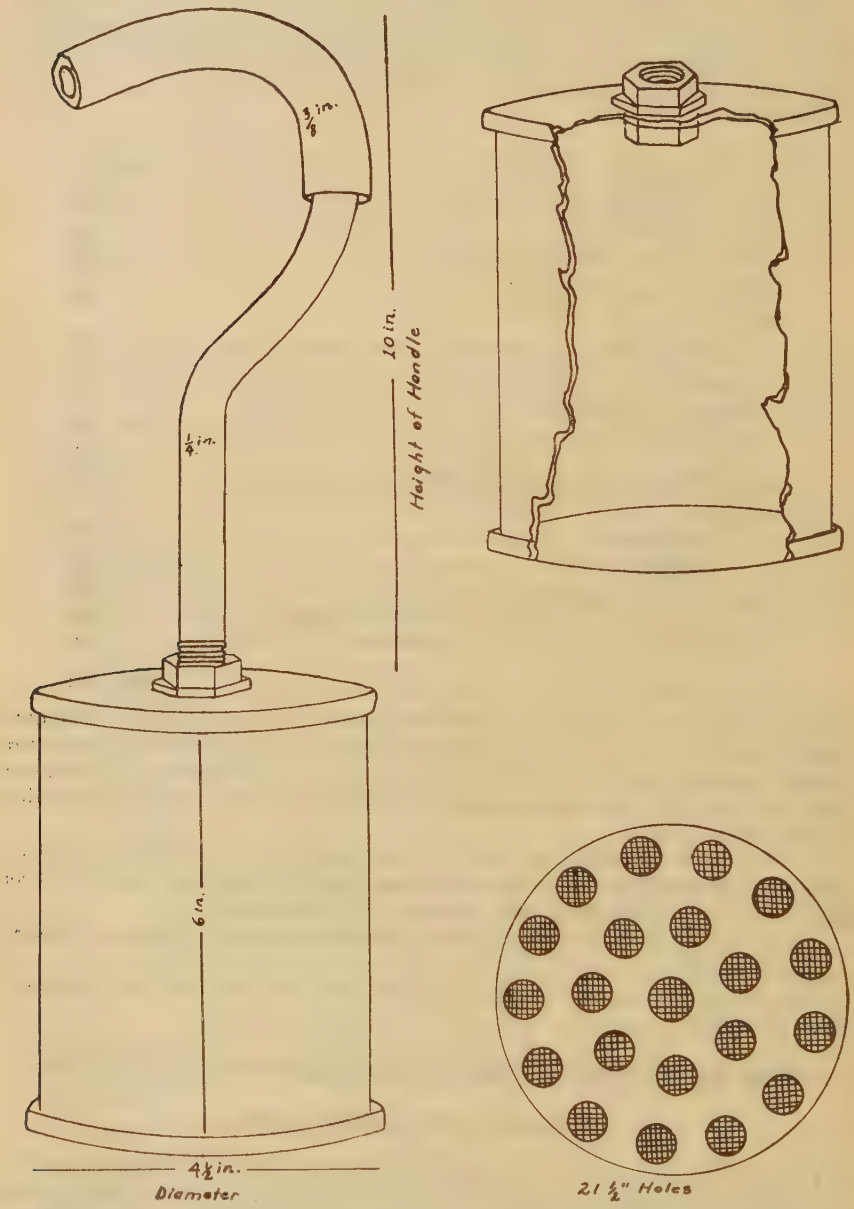

FIG. 1.—Improved device for aerating water in fish cans and removing sediment therefrom. The handle may be disconnected and the entire outfit carried in a small suitcase.

aerate 140 cans of fish for 14 hours without producing any apparent deterioration in the batteries, which have a capacity of 375 ampere hours.

"QUESTION MARK" AERATOR.

Within the last year the dipper that was used for aerating water has been largely replaced by the "question mark" aerator—so named on account of the bend in its handle—which is made of one-fourth inch pipe and serves as an air vent and means for suspending the aerator in a fish can when not in use. The cylinder of the aerator is made of galvanized rain spouting and is 4½ inches in diameter by 6 inches in length. The bottom contains 21 circular openings, which are screened to prevent fish from entering the cylinder. The handle may be unscrewed and the device carried in a small hand bag.

The device provides quick and efficient aeration, does not injure the fish, can be used to remove sediment or to lower the water in a container, and has a number of other advantages over the ordinary dipper. This aerator has met with general approval, as it seems to answer the bureau's needs better than any device that has been used heretofore.

JET AERATOR.

During the spring and summer of 1923 a new aerating device that circulates the water in the container and operates by air was used on the distribution cars to a limited extent and with very satisfactory results. This aerator was devised for the purpose of aerating the water and removing the carbon dioxide gas given off by the fish.

The device consists of a tube placed on the inside of a larger tube, care being taken to allow room enough to permit the water to be forced up in the space between the two tubes. Experiments with this device are still being carried on, and while its practicability is not generally perceived at the present time it is believed that it will be more fully appreciated when further improvements have been made in other transportation equipment.

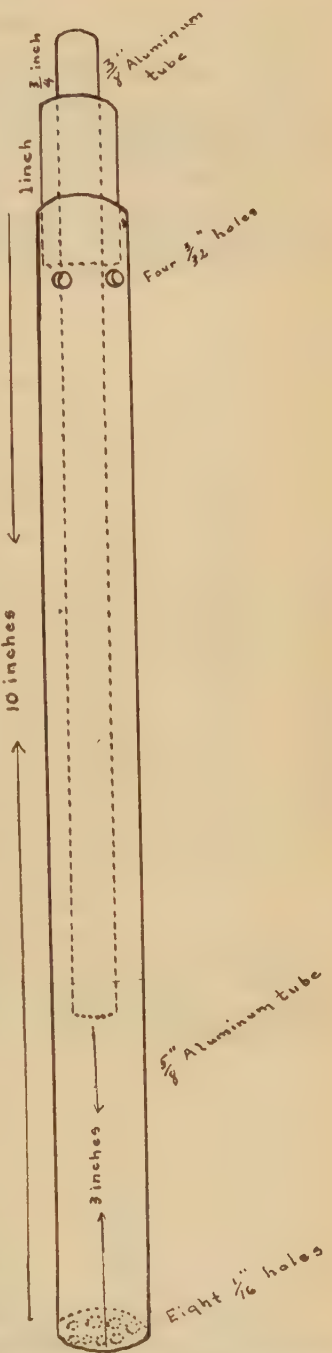

FIG. 2.—Device for circulating and aerating water in fish cans by means of compressed air.

AQUARIUM CLEANER.

The principle of the jet aerator may be successfully applied to a device for cleaning aquaria, as shown in Figure 3. It is necessary to use only a small amount of air in order to force waste material from the bottom of the aquarium to a receptacle on the outside. In fact, the air may be regulated so as to remove sand and gravel from the bottom of the aquarium. It is obvious that the lower end or intake should be provided with means for preventing the entrance of pebbles too large to pass through the outlet.

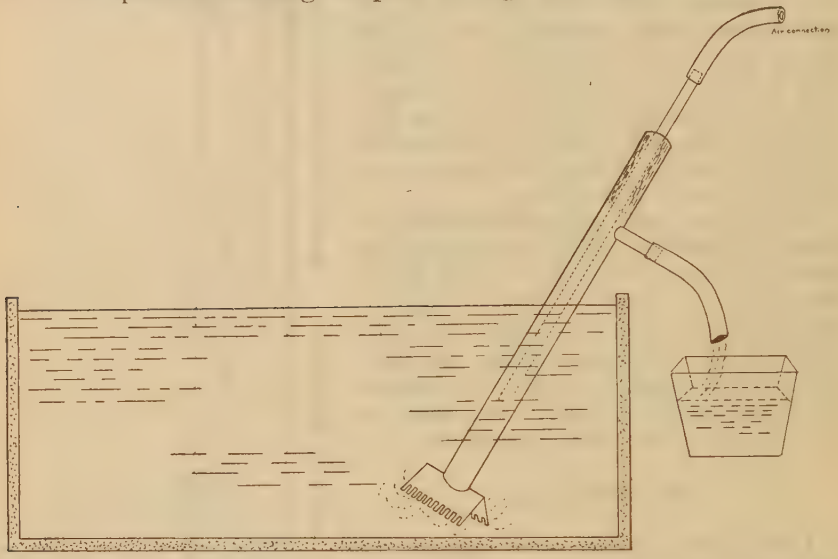

FIG. 3.—Aquarium cleaner operated by air pressure in the same manner as Figure 2.

COST OF DISTRIBUTION.

During the fiscal year 1923 the bureau honored 10,939 applications for fish, as compared with 10,376 in 1922. The following table gives comparative figures showing the cost of distribution for the fiscal years 1922 and 1923:

Fiscal year.	Number miles traveled.		Number of applications honored.	Cost of distribution.
	Cars.	Messengers.		
1922	77,128	306,215	10,376	$62,428.96
1923	80,118	345,387	10,939	58,751.71

During the past 20 years the output of the bureau's hatcheries has increased nearly 500 per cent, while the cost per thousand for transporting fish has been reduced 50 per cent during this period. In order to bring about this important reduction in distribution cost at a time when the cost of transportation, material, and supplies was

unusually expensive, it has been necessary to adopt the most improved methods of carrying living fish and at the same time exercise the most rigid economy.

The following table shows the magnitude of the bureau's distribution problem and the gradual reduction of distribution expenses that has been made during the past 20 years:

Comparison of the number of miles traveled by the bureau's cars and messengers and the cost of distribution from 1903 to 1923, inclusive, exclusive of salaries of statutory employees.

Year.	Total output of fish.	Miles traveled.						Total cost of distribution.	Cost of distribution per 1,000 fish.
		Cars.			Messengers.				
		Paid.	Free.	Total.	Paid.	Free.	Total.		
1903	1,226,057,475	52,852	26,526	79,378	174,535	85,492	260,027	$33,437.55	$0.027
1904	1,267,343,025	55,028	15,193	70,221	150,019	98,957	248,976	27,923.46	.022
1905	1,759,475,039	68,532	14,262	82,794	184,249	113,701	297,950	35,405.74	.020
1906	1,931,834,609	82,308	11,060	93,368	216,664	108,757	325,421	36,999.39	.013
1907	2,511,597,377	72,014	11,826	83,840	182,380	80,816	263,196	38,520.30	.015
1908	2,871,456,280	68,495	8,581	77,076	299,957	64,913	364,870	39,008.45	.013
1909	3,107,131,911	103,476	5,403	108,879	309,509	100,085	409,594	51,825.72	.016
1910	3,233,012,237	93,413	2,850	96,263	332,410	97,943	430,353	50,155.63	.015
1911	3,646,294,535	92,993	7,911	100,904	336,977	84,281	421,258	56,543.17	.015
1912	3,687,921,057	78,957	13,913	92,870	359,611	90,661	450,272	49,308.75	.013
1913	3,863,593,282	110,823	12,294	123,117	392,698	85,837	478,535	64,148.01	.016
1914	4,047,643,417	128,156	3,000	131,156	387,072	93,463	480,535	69,255.44	.017
1915	4,288,757,804	125,553	20,991	146,544	395,298	95,874	491,172	79,922.31	.018
1916	4,847,262,566	133,825	15,956	149,781	521,158	124,563	645,721	77,984.91	.016
1917	5,158,963,293	122,778	15,939	138,717	474,141	80,456	554,597	81,383.93	.015
1918	4,098,105,159	92,306	10,024	102,330	413,666	54,578	468,244	73,559.05	.017
1919	5,876,985,350	93,891	3,680	97,571	421,202	7,740	428,942	74,599.43	.012
1920	4,770,355,720	92,419		92,419	382,891	10,042	392,933	73,586.40	.015
1921	4,962,489,405	84,188	872	85,060	353,893	32,095	385,988	72,176.57	.014
1922	5,125,101,320	75,032	2,096	77,128	285,807	20,408	306,215	62,428.96	.012
1923	4,314,859,029	78,595	1,525	80,118	307,983	37,404	345,387	[1] 58,751.71	.013

[1] $4,000 of this amount was spent for new equipment.

Method of distribution, by stations, species, number and size of fish, and costs.

DISTRIBUTION BY CAR MESSENGERS.[1]

	Species.	Number of fish.	Size.	Total cost.	Average cost per thousand.	Miles paid.	Miles free.
Bozeman, Mont.	Trout	23,900	Fry	$13.07	$0.547	161	
	do	70,750	Fingerlings, 1-inch	48.77	.689	728	
	do	216,150	Fingerlings, 1 to 4 inch	241.45	1.112	3,923	1,471
Craig Brook, Me.	Salmon	682,500	Fry	104.55	.153	1,717	
	do	40,000	Fingerlings, 2-inch	81.27	2.317	919	56
	Pond fishes	96	Adult	54.19	564.468	690	92
	Trout	83,200	Fry	13.70	.165	112	32
	do	469,000	Fingerlings, 1-inch	101.97	.218	2,070	
	do	110,200	Fingerlings, 1½-inch	41.20	.374	573	
Duluth, Minn.	do	23,000	Fingerlings, 1-inch	23.12	1.005	414	
Erwin, Tenn.	Pond fishes	539,500	Fry	92.26	.670	678	
	Trout	190,150	Fingerlings, 1 to 2 inch	137.45	.723	1,604	
Leadville, Colo.	do	462,000	Fingerlings, 1-inch	365.93	.792	5,528	
	do	275,500	Fingerlings, 1½-inch	140.08	.507	1,615	
	do	36,000	Fingerlings, 2½-inch	78.08	2.169	907	
Manchester, Iowa	do	72,200	Fingerlings, 1 to 1½ inch.	56.53	.783	3,666	
	do	54,800	Fingerlings, 1½-inch	68.31	1.064	668	
	do	184,600	Fingerlings, 2½-inch	166.67	.903	2,157	
Northville, Mich	Pond fishes	6,000	Fingerlings, 1-inch	91.03	15.171	1,377	712
	do	7,200	Fingerlings, 2-inch	102.00	14.167	1,325	
	do	1,575	Fingerlings, 2 to 3 inch	30.21	19.117	540	

[1] Detached messenger shipments from cars. Cost in addition to "distribution by car."

Method of distribution, by stations, species, number and size of fish, and costs—Continued.

DISTRIBUTION BY CAR MESSENGERS—Continued.

	Species.	Number of fish.	Size.	Total cost.	Average cost per thousand.	Miles paid.	Miles free.
Upper Mississippi.[2]	Pond fishes	16,300	Fingerlings, 1-inch	$56.87	$3.428	1,016	
	do	3,944	Fingerlings, 2-inch	49.32	12.505	560	
	do	25,520	Fingerlings, 2 to 3 inch	242.31	9.137	2,781	176
	do	46,795	Fingerlings, 3-inch	362.21	7.740	4,878	
	do	2,200	Fingerlings, 4-inch	34.26	15.573		598
	do	103,053	Fingerlings, 1-inch; Yearlings	831.55	8.070	11,729	
	do	84,559	Fingerlings, 1-inch; Adults	1,004.77	11.871	13,558	
	do	496	Yearlings	21.45	43.271	294	94
	Trout	111,000	Fingerlings, 1-inch	59.27	.534	948	
	do	28,800	Fingerlings, 1½-inch	23.21	.806	280	
White Sulphur Springs, W. Va.	do	54,000	do	45.93	.851	561	
	do	31,125	Fingerlings, 1½ to 2½ inch.	62.81	2.018	855	
	do	231,200	Fingerlings, 2-inch	381.49	1.217	3,809	312
	do	750	Fingerlings, 3-inch	35.56	47.413	666	
	do	43	Adults	27.64	642.791	490	
Wytheville, Va.	do	10,000	Fingerlings, 1-inch	10.62	1.062	120	
	do	51,750	Fingerlings, 1½-inch	48.54	.938	698	
	do	17,500	Fingerlings, 1½ to 2½ inch.	25.42	1.452	195	
	do	84,100	Fingerlings, 2-inch	104.32	1.240	1,460	26

DISTRIBUTION BY STATION MESSENGERS.[3]

Bozeman, Mont.	Trout	100,000	Fry	$31.95	$0.320	594	
	do	133,000	Fingerlings, 1-inch	63.09	.474	1,148	
	do	99,950	Fingerlings, 1 to 2 inch	72.16	.722	1,179	271
Cape Vincent, N. Y.	Lake herring	3,000,000	Fry	19.46	.606		
	Pike perch	600,000	do	26.65	.045	204	914
	Whitefish	10,190,000	do	43.71	.004		
	Trout	583,000	do	165.68	.284	1,172	4,153
Central Station	Pond fishes	2,000,000	do	23.15	.012	420	
	do	6,000	Fingerlings, 1½-inch	24.95	4.159	511	
	do	10,000	Fingerlings, 2-inch	50.97	5.097	794	
	Trout	33	Adults	26.79	811.818	490	
Clackamas, Oreg.	Salmon	6,000	Fingerlings, 1-inch	55.53	9.250	638	
	Trout	218,500	Fry to fingerlings, 2½-inch.	43.24	.198	863	
	do	122,000	Fingerlings, 1-inch	127.58	1.046	2,291	
	do	102,000	Fingerlings, 1½-inch	101.17	991	1,614	
	do	7,000	Fingerlings, 2½-inch	14.85	2.120	377	
Craig Brook, Me.	do	40,000	Fingerlings, 1½-inch	35.34	.893	610	
Duluth, Minn.	Whitefish	2,700,000	Fry	24.80	.009		
	Pond fishes	5,715,000	do	124.64	.022	1,845	
	do	1,150,500	Fry to fingerlings, 1½-inch.	190.75	.165	2,869	
	Trout	8,890,000	Fry	1,026.33	.115	406	
	do	840,000	Fry to fingerlings, 1-inch.	72.71	.087	1,048	
	do	115,000	Fingerlings, 1-inch	134.59	1.169	2,113	
	do	56,000	Fingerlings, 1½-inch	65.85	1.177	1,015	
Edenton, N. C.	Shad	200,000	Fry	10.52	.052	180	
	Pond fishes	34,625	Fry to fingerlings, 1½-inch.	118.96	3.435	2,099	
	do	9,600	Fingerlings, 1-inch	19.91	2.250	328	
	do	13,450	Fingerlings, 1½-inch	72.71	5.406	1,157	
	do	3,745	Fingerlings, 1½ to 4 inch	38.98	10.410	696	
Erwin, Tenn.	Salmon	600	Adults	39.18	65.300	500	
	Trout	39,800	Fingerlings, 1 to 2-inch	17.40	.438	160	
	do	23,500	Fingerlings, 2-inch	21.71	.924	208	
	do	126,000	Fingerlings, 2½-inch	76.31	.616	836	
	do	7,500	Fingerlings, 3 to 4 inch	71.86	9.580	805	
	Pond fishes	43,862	Fingerlings, 1 to 4 inch	361.47	8.240	5,785	
	do	88	Adults	28.75	326.705	443	
Hartsville, Mass.	do	325,000	Fry	27.29	.084	387	
	Trout	261,400	Fingerlings, 1 inch	81.48	.031	1,169	
	do	4,400	Fingerlings, 1½-inch	15.88	3.600	202	178

[2] La Crosse, Wis.; Bellevue, Iowa; Marquette, Iowa; and Homer, Minn.

[3] Distribution by station messengers includes cost of making distribution direct from the station without a car. This distribution is usually to near-by points.

Method of distribution, by stations, species, number and size of fish, and costs—Continued.

DISTRIBUTION BY STATION MESSENGERS—Continued.

	Species.	Number of fish.	Size.	Total cost.	Average cost per thousand.	Miles paid.	Miles free.
Leadville, Colo.	Pond fishes	39,250	Fingerlings, 1-inch	$29.27	$0.746	434	
	Trout	375,000	Fry	215.29	.574	2,633	40
	do	1,377,000	Fingerlings, 1-inch	630.21	.458	7,895	785
	do	118,500	Fingerlings, 1 to 1½ inch	94.34	.796	1,122	
Louisville, Ky.	Pond fishes	309,750	Fry	67.17	.217	1,263	
	do	63,100	Fingerlings, 1½ to 2 inch	203.49	3.224	4,121	
	do	1,800	Fingerlings, 2 to 3 inch	19.34	10.850	314	
	do	3,400	Fingerlings, 3-inch	26.77	7.930	518	
	do	3,000	Fingerlings, 4-inch	21.77	7.250	448	
Mammoth Spring, Ark.	do	121,000	Fingerlings, 1-inch	282.23	2.332	5,892	
	do	4,000	Fingerlings, 1 to 2½ inch	47.61	11.903	814	
	do	14,000	Fingerlings, 1½-inch	127.12	9.080	1,938	
Manchester, Iowa	do	4,130	Fingerlings, 1-inch Yearlings	47.45	10.156	739	42
	do	143	Adults	87.66	365.454	1,434	
Nashua, N. H.	do	8,400	Fry	43.15	5.137	747	
	do	4,300	Fingerlings, 1½-inch	18.31	4.258	334	
	do	7,100	Fingerlings, 2-inch	26.36	3.710	472	
	Trout	2,500	Fry	4.01	1.740	31	
	do	120,000	Fingerlings, 1-inch	31.10	.242	532	
	do	334,960	Fingerlings, 1½-inch	351.68	1.471	5,914	47
	do	17,700	Fry to fingerlings, 2 inch.	66.24	3.790	1,166	13
	do	580	Adults	46.36	79.930	862	
Neosho, Mo.	Pond fishes	1,700,000	Fry	17.95	.010	331	
	do	3,600	Fingerlings, 2-inch	6.60	1.840	110	
	do	4,000	Fingerlings, 3-inch	41.97	10.493	837	
	do	17,774	Fingerlings, 1 to 4 inch	158.39	8.911	3,064	
	do	1,012	Adults	225.02	221.364	3,927	
	Trout	43,100	Fingerlings, 2-inch	98.47	2.284	1,818	106
	do	23,400	Fingerlings, 2½-inch	43.14	1.416	670	426
	do	13,000	Fingerlings, 1 to 4½ inch	42.51	3.270	780	119
	do	2,700	Fingerlings, 2-inch Yearlings	9.30	3.460	143	
Northville, Mich.	Whitefish	1,770,000	Fry	40.61	.023		1,423
	Salmon	10,000	do	15.83	1.583	224	
	Pond fishes	28,000	do	4.90	.179		686
	do	5,650	Fingerlings, 1-inch	18.31	3.241	50	424
	do	4,200	Fingerlings, 1 to 2 inch	8.75	2.083		454
	do	5,300	Fingerlings, 2-inch	26.50	5.000		1,620
	do	1,205	Fingerlings, 3 to 6 inch	23.94	19.870		329
	do	80	Adults	11.56	144.500		524
	Trout	432,500	Fry	122.45	.283	710	3,395
	do	48,500	Fingerlings, 1-inch	19.37	.399		861
	do	99,000	Fingerlings, 1½-inch	57.50	.581		4,246
Orangeburg, S. C.	Pond fishes	93,150	Fry	93.85	1.007	1,346	84
	do	168,850	Fingerlings, 1-inch	258.33	1.529	3,273	73
	do	18,000	Fingerlings, 1½-inch	32.01	1.778	351	
	do	65,120	Fingerlings, 1 to 6 inch	295.07	4.531	3,748	160
St. Johnsbury, Vt.	Salmon	11,018	Fry	1.75	.158		(1)
	Trout	734,000	do	184.60	.252	2,326	78
	do	6,500	Fingerlings, 2-inch	49.24	7.575	730	83
	do	9,200	Fingerlings, 2½-inch	45.84	4.983	743	5
	do	1,100	Fingerlings, 3-inch	12.87	11.700	60	
San Marcos, Tex.	Pond fishes	33,900	Fry to fingerlings, 1 inch.	50.91	1.502	889	
	do	3,200	Fingerlings, 1½-inch	37.23	11.630	644	
	do	2,250	Fingerlings, 2-inch	(1)			
	do	7,442	Fingerlings, 3-inch	48.47	6.513	698	
	do	225	Fingerlings, 4-inch	(1)			
	do	235	Fingerlings, 5-inch	(1)			
	do	700	Fingerlings, 6-inch	29.61	42.300	584	
	do	225,442	Fingerlings, 1-inch Adults	1,088.43	4.775	16,871	
	do	1,238	do	2.67	2.157	18	
Saratoga, Wyo.	Trout	71,800	Fingerlings, 1-inch	17.34	.120	327	61
	do	36,000	Fingerlings, 1½-inch	22.31	.620	213	21
	do	14,100	Fingerlings, 1½ to 2 inch	11.21	.610	212	20
	do	40,000	Fingerlings, 2-inch	32.91	.919	544	96
Spearfish, S. Dak.	do	649,500	Fingerlings, 1½-inch	165.68	.255	1,824	
	do	136,601	Fingerlings, 1 to 3 inch	65.12	.477	938	
	do	2,600	Fingerlings, 2-inch	(1)			
Springville, Utah	do	135,000	do	121.55	.901	1,395	2,629
	do	54,750	Fingerlings, 2½-inch	160.59	2.903	2,269	1,929
	do	10,700	Fingerlings, 1½ to 4 inch	25.28	2.362	275	266
	do	234,150	Fingerlings, 3-inch	202.07	.862	2,540	6,205
	do	27,000	Fingerlings, 4-inch	83.44	3.090	1,198	470

1 Station delivery.

Method of distribution, by stations, species, number and size of fish, and costs—Continued.

DISTRIBUTION BY STATION MESSENGERS—Continued.

	Species.	Number of fish.	Size.	Total cost.	Average cost per thousand.	Miles paid.	Miles free.
Tupelo, Miss	Pond fishes	307,500	Fry	$205.61	$0.668	3,867	36
	do	112,200	Fingerlings, 1-inch	280.45	2.491	4,821	44
	do	15,600	Fingerlings, 2-inch	60.16	3.856	1,101	26
	do	176,841	Fingerlings, 1-inch; Adults	1,084.78	6.134	18,472	90
	do	140	Adults	33.35	238.210	701	
Upper Mississippi.[2]	do	2,100,000	Fry	36.99	.017	722	
	do	23,805	Fingerlings, 2 to 3 inch	232.17	9.753	3,875	
	do	46,185	Fingerlings, 2 to 6 inch	288.76	6.252	5,648	
	do	17,461	Fingerlings, 3-inch	145.99	8.361	2,211	
	do	1,980	Fingerlings, 3 to 4 inch	64.99	32.166	1,148	
	do	18,468	Fingerlings, 1 to 6 inch	86.37	4.677	1,128	
	do	263	Adults	5.08	19.316	42	
	Trout	144,000	Fingerlings, 1-inch	50.74	.345	598	
	do	33,600	Fingerlings, 1½-inch	13.63	.406	238	
White Sulphur Springs, W. Va.	Pond fishes	46,500	Fry	45.30	.975	724	
	do	32,000	Fingerlings, 1-inch	31.47	.980	520	
	Trout	31,500	do	11.81	.375	245	
	do	42,500	Fingerlings, 1½-inch	64.01	1.506	1,056	
	do	47,330	Fingerlings, 2-inch	90.15	1.925	1,370	
	do	3,130	Fingerlings, 2 to 3 inch	46.13	14.738	869	
	do	450	Fingerlings, 3-inch; Adults	28.22	62.711	572	
Woods Hole, Mass.	Pond fishes	475	Fingerlings, 4-inch; Adults	47.29	99.547	391	622
	Flatfish	31,949,000	Fry	36.34	.001	460	
Wytheville, Va	Pond fishes	15,562	Fingerlings, 1 to 3 inch	229.62	14.755	3,792	
	do	800	Fingerlings, 2-inch	19.13	20.380	276	
	do	8,725	Fingerlings, 2 to 3 inch	121.65	14.456	2,109	
	Trout	54,000	Fingerlings, 1-inch	49.46	.916	760	
	do	28,000	Fingerlings, 1 to 2 inch	40.57	1.449	694	
	do	9,000	Fingerlings, 2-inch	11.77	1.307	222	
	do	64,350	Fingerlings, 1½ to 2½ inch.	142.19	2.209	1,888	
Warm Springs, Ga.	Pond fishes	163,800	Fry	254.49	1.553	4,169	
	do	31,800	Fingerlings, 1-inch	113.68	3.575	1,557	
	do	56,600	Fingerlings, 1½-inch	307.01	5.424	5,015	
	do	73,425	Fry to fingerlings, 4-inch.	379.34	5.165	6,223	

DISTRIBUTION BY CARS.[5]

Bozeman, Mont	Trout	974,150	Fry to fingerlings, 4-inch.	$2,165.53	$2.223	5,264	722
Bucksport, Me	Salmon	371,000	Fry to fingerlings, 1½-inch.	112.98	.304	258	
	Trout	869,900	do	665.35	.763	1,976	
Duluth, Minn	do	2,533,000	Fry	1,201.45	.474	2,671	1,523
Erwin, Tenn	do	710,900	Fingerlings, 1 to 2 inch	1,191.74	1.676	2,811	
Langdon, Kans	Pond fishes	9,000	Yearlings	138.40	15.380	685	
Leadville, Colo	Trout	1,050,500	Fingerlings, 1 to 1½ inch	1,405.99	1.340	4,250	
Manchester, Iowa	do	536,000	Fingerlings, 1 to 2 inch	954.05	1.780	4,052	
Northville, Mich	do	38,000	Fingerlings, 1 to 2½ inch	328.21	8.611	2,646	
Upper Mississippi.[2]	Pond fishes	2,912,527	Fingerlings, 1-inch, to adults.	13,423.85	4.610	38,243	
	Trout	156,275	Fingerlings, 1 to 2½ inch	359.00	2.290	1,080	
White Sulphur Springs, W. Va.	do	439,450	Fingerlings, 1 to 2 inch	2,505.61	5.701	6,558	
Wytheville, Va	do	257,650	Fingerlings, 1-inch, to yearlings.	1,061.30	4.119	2,709	

[2] La Crosse, Wis.; Bellevue, Iowa; Marquette, Iowa; and Homer, Minn.
[5] Distribution by cars shows cost of transporting fish to destination or until delivered to car messenger.

FEB 1955
LIBRARY
POFI
FISH & WILDLIFE
SERVICE